D. S. I. R.
National Central Library
for Science and
Technology.

CONCRETE AND CONSTRUCTIONAL ENGINEERING

INCLUDING PRESTRESSED CONCRETE

3400 A

DECEMBER 1957 VOL. LII. NO. 12

FIFTY-SECOND YEAR OF PUBLICATION

PRICE 1s. 9d. ANNUAL SUBSCRIPTION 21s., POST FREE. $3.90 in Canada and U.S.A.

LEADING CONTENTS

	PAGE
The Design of Factories	395
The Use of High-Tensile Steel Reinforcement *By K. Hajnal-Kónyi*	397
Book Reviews	410
Design of Eccentrically-Loaded Columns by the Load-Factor Method *By J. D. Bennett*	411
The New Notation in B.S. Code of Practice No. 114 (1957)	417
Earthquake Damage in Mexico City	422

No. 601 ISSUED MONTHLY Registered for Canadian Magazine Post

BOOKS ON CONCRETE For catalogue of "Concrete Series" books on concrete and allied subjects, send a postcard to CONCRETE PUBLICATIONS LTD., 14 DARTMOUTH ST., LONDON, S.W.1.

REINFORCED CONCRETE DESIGNER'S HANDBOOK

By Chas. E. Reynolds

NEW EDITION NOW READY

352 Pages 75 Tables 110 Examples

Revised in accordance with British Standard Code 114 : 1957

The fifth edition of this handbook is in accordance with the recommendations of the British Standard Code of Practice No. 114 (1957), a special feature being the inclusion of tables and data for use with the ultimate-load method of design. Other improvements and additions have been made to the text and tables dealing with the pressures of granular and cohesive materials, foundations, slabs supported on three or four sides and subjected to triangular loading, loads on bridges, long columns, and the properties of reinforced concrete sections.

ORDER FORM

To CONCRETE PUBLICATIONS, Ltd.,
14 DARTMOUTH STREET, LONDON, S.W.1, England.

Please send.....copy (copies) of

"Reinforced Concrete Designer's Handbook," by Chas. E. Reynolds.

18*s.*; 19*s.* 5*d.* by post. 4 dollars in Canada and U.S.A.

A remittance for.....is enclosed.

BLOCK CAPITALS PLEASE

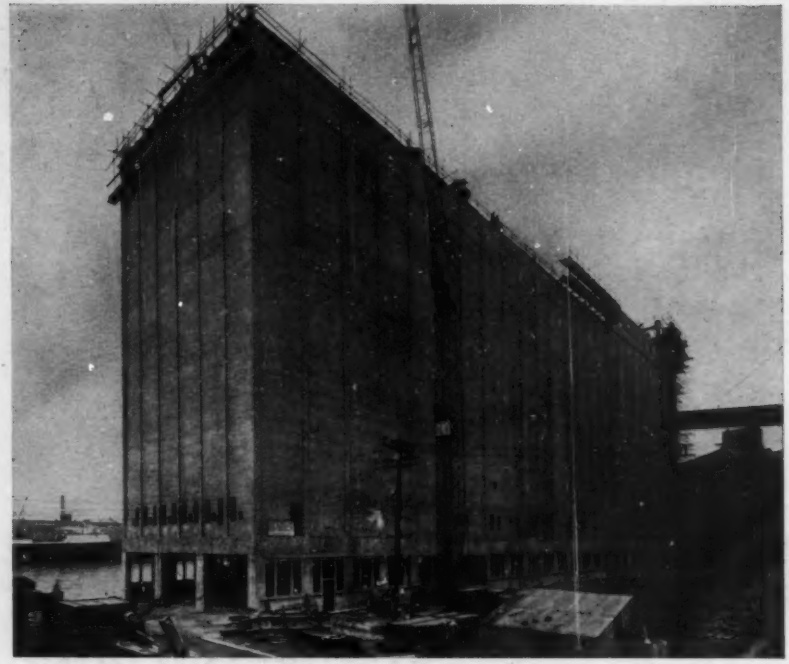
NAME .....

ADDRESS .....

.....

.....

Remittances from Canada and U.S.A. may be made in the ordinary way by drawing a check on the customer's bank made payable to Concrete Publications, Ltd., in dollars and cents or by International Money Order, obtainable at a Post Office.



Built in 6 days with Prometo Forms

This 100-foot high silo for the Liverpool Grain Storage and Transit Company Ltd., took exactly six days and nights to build. The Prometo Moving Forms rose under hydraulic pressure at a rate of 17-ft. per day. William Thornton are the sole U.K. licensees for this Swedish method of rapid and reliable monolithic construction in concrete.

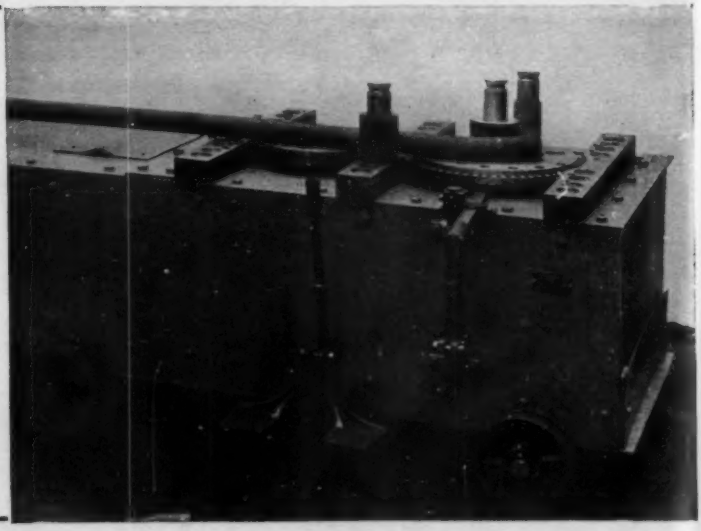
William **THORNTON** & Sons Ltd

38 WELLINGTON ROAD - LIVERPOOL

LARk Lane 1921 (4 lines) *Telegrams:* "Thornpool Liverpool"

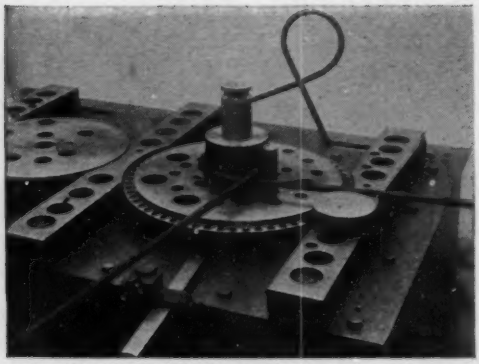
A

for bars from $\frac{1}{4}$" to 2" dia.



BAR-BENDING

with accuracy·speed·economy



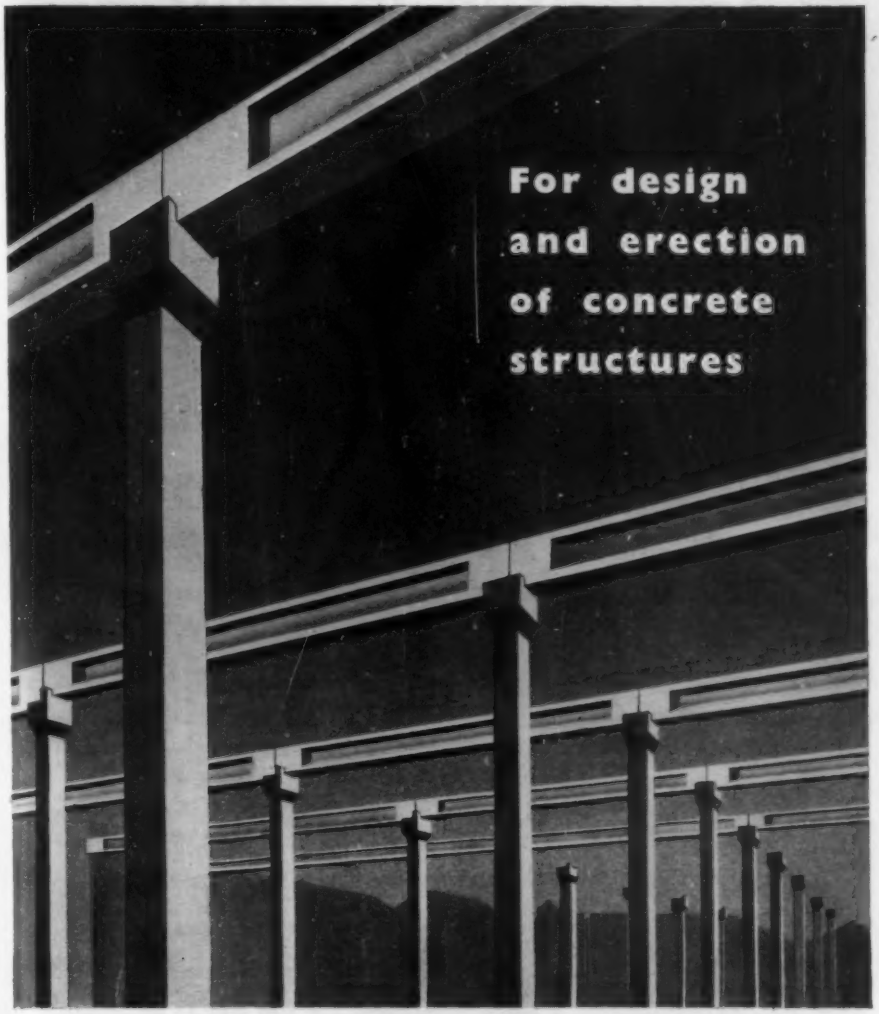
ARD-50 MODEL

ELECTRIC OR ENGINE DRIVEN

The ARD-50 Model, illustrated above, has an automatic control which permits the desired bending angle to be pre-set, greatly facilitating repetition bending. The bottom illustration shows the bending of an angle loop in one operation. This model is also fitted with a backrest for multiple bending of small diameter bars. We also supply, at extra cost, a special device for bending Hoops and Spirals, and formers and backrests for special steel such as "Square Grip," "Twisteel," and "Tentor," etc. This model is complete with standard accessories for bends on a 4D basis, and can be fitted with Electric motor, Air-cooled Petrol engine or Air- or Water-cooled Diesel engine. Our range of bending equipment also includes the RAS40 model for bending bars up to $1\frac{1}{2}$ in. diameter. Both models are available for sale or hire. Full details will be sent on request.

CEMENT & STEEL, LTD., SECOND AVENUE, CHATHAM, KENT.

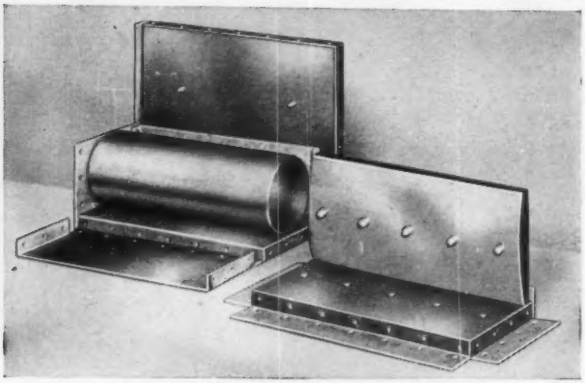
Telephone : Chatham 45580. *Telegrams & Cables :* Cembelgi, Chatham.



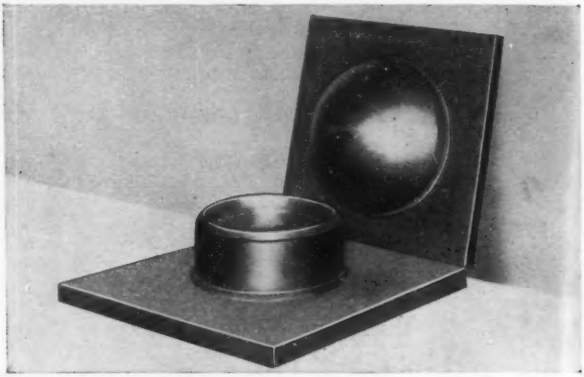
CONCRETE SERVICES
LIMITED

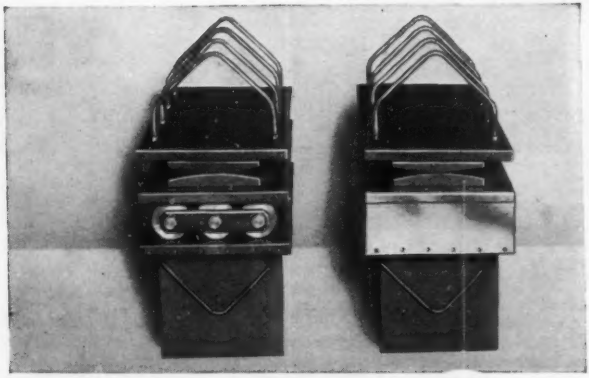
OUSE ACRES
BOROUGHBRIDGE ROAD
YORK Telephone: 78475

Bridge Bearings by WESTWOODS



Illustrated are a few examples of various Bridge Bearings recently constructed by Westwoods.





Bridge and Constructional Engineers, Manufacturers of Mechanical Grabs, Pressed Steel Troughing and Sheet Metal Equipment. Steel Stock Holders.

JOSEPH WESTWOOD & CO. LTD.

NAPIER YARD, MILLWALL, LONDON, E.14 **Phone: EASt 1043**

22 TONS OF GUARDSMEN

Higgs and Hill Ltd., Main Civil Engineering Contractors

prove the qualities of Somerset Prestressed Concrete Wire

Marching and countermarching, standing and stamping, 300 Guardsmen tested on behalf of the Ministry of Works the new concrete footbridge in St. James's Park, London, providing a convincing demonstration of its strength. This bridge owes much of its stability and high stress-resistance to the Somerset Prestressed Concrete Wire which was used throughout its construction.

Somerset Prestressed Concrete Wire is a high tensile wire noted for its great elasticity and ductility, its low stress relaxation and its outstanding resistance to fire.
It is available either plain or helically crimped to give maximum bond with the concrete.

SOMERSET WIRE CO. LTD.

Bridgwater, Somerset. Tel: Bridgwater 3001/2
Telegrams: Somwire, Bridgwater.

SOMERSET WIRE COMPANY LTD · BRIDGWATER · SOMERSET · S W

One of the GKN Group of Companies.

SCHMIDT CONCRETE TEST HAMMER

for immediate non-destructive determination of compressive strength

THREE MODELS AVAILABLE

TYPE N 2.—For normal concrete

TYPE M—For mass concrete (dams, roads, runways, etc.)

TYPE L—For lightweight concrete, and other fragile materials.

O. A. VOLKMANN, 3 ST. AUGUSTINE'S ROAD, BIRMINGHAM 16

Telephone : Edgbaston 1353

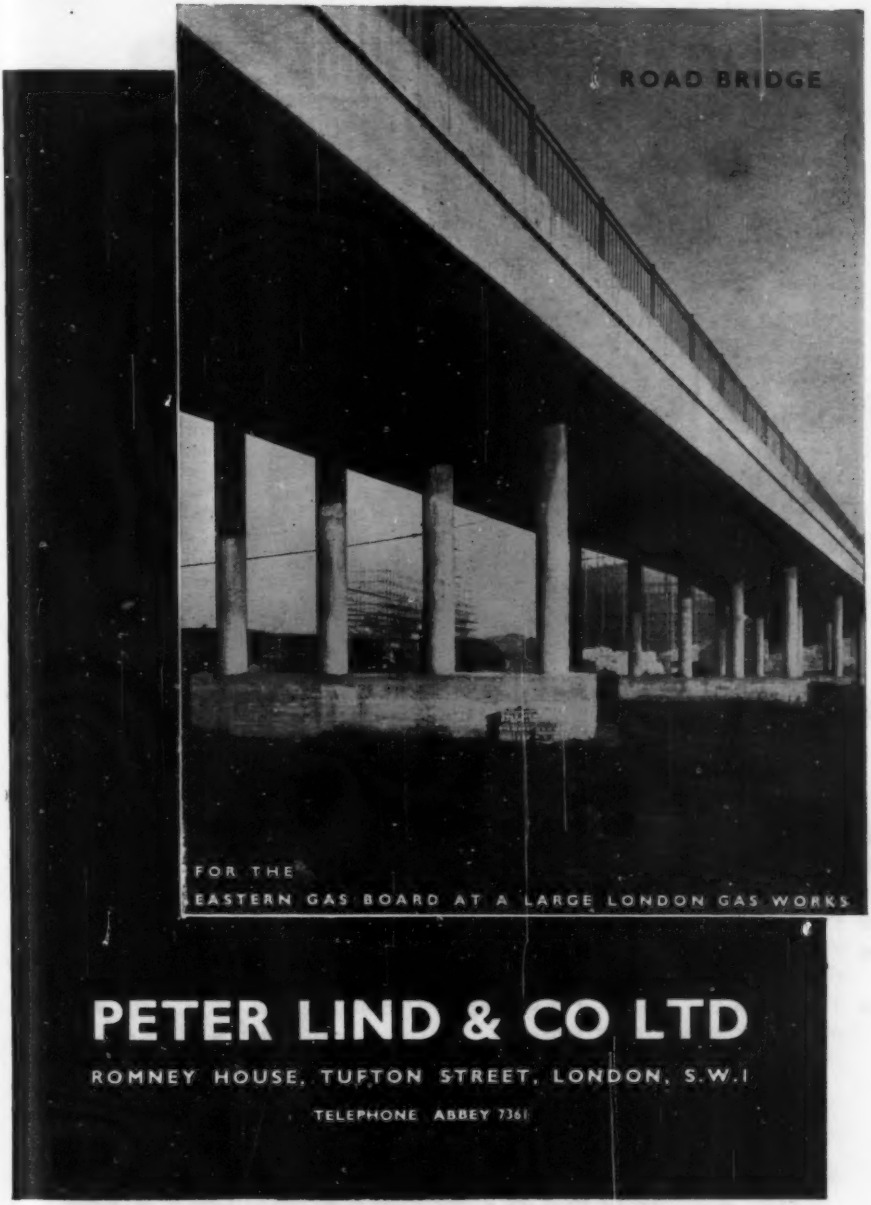
GUNITE SPECIALISTS

WM. MULCASTER & CO. (CONTRACTORS) LTD.

We invite inquiries for Gunite Linings and Renderings for new or old structures of every kind in any part of the country.

HASLINGTON **CREWE**

Telephone : Crewe 2265-6.



PETER LIND & CO LTD

ROMNEY HOUSE, TUFTON STREET, LONDON, S.W.1

TELEPHONE ABBEY 7361

An Electrically Driven PC3 Concrete Pump with remixer. Capacities from 20 to 24 cu. yds. per hour. Ranges actually obtained 135 ft. vertical or 1,500 ft. horizontal. Also smaller model PC4—8–10 cu. yds. per hour.

FOR SALE AND HIRE

EFFICIENT RECONDITIONING SERVICE

CONCRETE BY PUMP AND PIPELINE

- The latest and most efficient method of placing concrete.
- Life of Pump practically indefinite : all essential surfaces in contact with concrete are renewable.
- Pumpable concrete must of necessity be good concrete.
- Pump and Mixing Plant can be located at the most convenient position within the pumping range.
- The continuous output of the Pump at a constant speed governs the working of the whole concreting gang.

THE REGISTERED TRADE MARK OF **PUMPCRET** THE CONCRETE PUMP COMPANY LIMITED

THE CONCRETE PUMP COMPANY LTD

4 STAFFORD TERRACE, LONDON, W.8

Telephone : Western 3546 **Telegrams : Pumpcret, Kens, London**

JOHNSON

TAMPING AND SCREED BOARD VIBRATORS

COMPACTS DOWN TO 8 INCHES

Depending on the harshness of the mix
down to 8" perfect compaction can be achieved
by this single vibrating unit,
driving up to 24' tamping boards.
Easily operated by unskilled labour
and inexpensive to maintain,
Johnson Tamping and Screed Board Vibrators
are ideal for concrete roads and floor slabs.
Write for details.

JOHNSON TAMPING & SCREED BOARD VIBRATORS

C. H. JOHNSON (Machinery) LTD · ADSWOOD · STOCKPORT · CHESHIRE

Telephone : Stockport 2642/5 Telegrams : "Machinery" Stockport.

LONDON SALES AND SERVICE DEPOT : 38/44 Lower Richmond Road, London, S.W.14. Telephone : PROspect 7671.

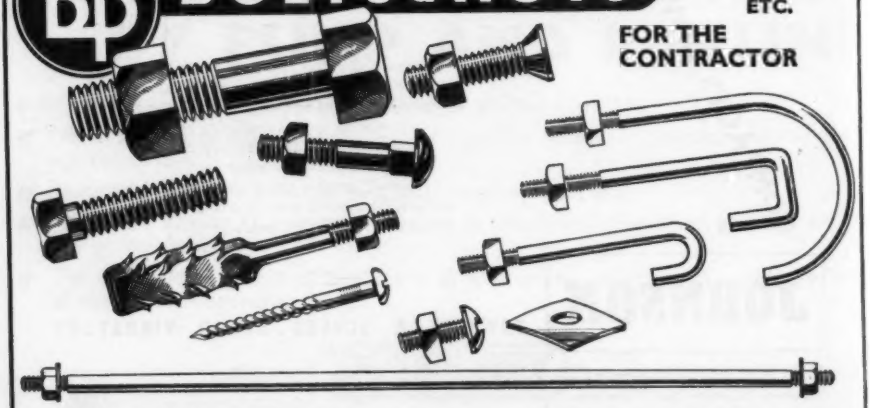
SCOTTISH SALES AND SERVICE DEPOT : 55 Arrowsmith Ave., Glasgow, W.3. Telephone : Scotstoun 6933.

By testing 6" cubes on the Site
£260 can be saved on one contract—
this pays for the Milbank-Wells Press
and 3 cube moulds.
For the Factory using smaller aggregates
you get the 4" Press and moulds for £138
Prices include immediate delivery in UK

SEE PAGE xxxvi

MILBANK FLOORS LTD., RIVER HOUSE, EARLS COLNE, ESSEX

BD BOLTS & NUTS TIE-RODS ETC.
FOR THE CONTRACTOR



Manufactured by
B. PRIEST & SONS LTD · OLD HILL · STAFFS · ENG.
PHONES: CRADLEY HEATH 6227-8-9 & 6220

An Organisation tuned to ensure the highest quality construction in the shortest possible time.

Technical skill and 'know how' gained in the hard school of experience.

Equipment large and small and the ability to utilise it to the best advantage.

But above all, a proud record associating our name with innumerable extensive constructional activities encompassing Civil Engineering, Industrial Building, Site Investigation, Stabilised Soil Construction, Excavation, Foundations, Reinforced and Prestressed Concrete, Factories, Roads, Bridges, Piling, Sewerage, Waterways.

Messrs. Cadbury Bros. Ltd.

College of Further Education—Hartford.
(First instalment illustrated)

Thames Board Mills Ltd.

monk Warrington and London

A. MONK & COMPANY LIMITED

Head Office:
Padgate, Warrington.
Telephone: Warrington 31288

London Office:
75 Victoria Street, S.W.1.
Telephone: Abbey 2651

Offices at: Stamford, Hull & Middlesbrough

5644-1

With lovely patterns to make on icy windows, cold weather may bring joy to some—but not to the builder and contractor with urgent concrete work in hand. By taking special precautions, however, one of which is to use '417 Cement', expensive delays can be avoided, even in severe weather conditions. Please write for booklet giving full details.

A BLUE CIRCLE PRODUCT CMC

'417 cement'

QUICK SETTING—EXTRA RAPID HARDENING

SUPPLIED BY THE CEMENT MARKETING COMPANY LIMITED, PORTLAND HOUSE, TOTHILL STREET, LONDON, S.W.1.
G. & T. EARLE LTD., HULL. THE SOUTH WALES PORTLAND CEMENT & LIME CO. LTD., PENARTH, GLAM.

REINFORCED CONCRETE DESIGNER'S HANDBOOK

By Chas. E. Reynolds

NEW EDITION NOW READY

352 Pages 75 Tables 110 Examples

Revised in accordance with British Standard Code 114 : 1957

The fifth edition of this handbook is in accordance with the recommendations of the British Standard Code of Practice No. 114 (1957), a special feature being the inclusion of tables and data for use with the ultimate-load method of design. Other improvements and additions have been made to the text and tables dealing with the pressures of granular and cohesive materials, foundations, slabs supported on three or four sides and subjected to triangular loading, loads on bridges, long columns, and the properties of reinforced concrete sections.

ORDER FORM

To CONCRETE PUBLICATIONS, Ltd.,
14 DARTMOUTH STREET, LONDON, S.W.1, England.

Please send.....copy (copies) of

"Reinforced Concrete Designer's Handbook," by Chas. E. Reynolds.

19s. 2d. by post. 4 dollars in Canada and U.S.A.

A remittance for.....is enclosed.

BLOCK CAPITALS PLEASE

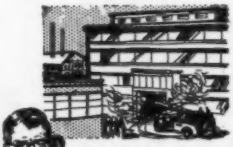
NAME .....

ADDRESS .....

.....

.....

Remittances from Canada and U.S.A. may be made in the ordinary way by drawing a check on the customer's bank made payable to Concrete Publications, Ltd., in dollars and cents or by International Money Order, obtainable at a Post Office.



UNDERGROUND FIRE THREATENS
MILLION POUND FACTORY BUILDING

RESERVOIR LOSING 10,000 GALLONS
A DAY FROM LEAKAGE

CATHEDRAL FOUNDATIONS
UNSAFE

SEA BREAKS INTO
MAIN SEWER

PITHEAD WINDING GEAR FOUNDATIONS
NEED STRENGTHENING

TUNNEL LINING WEAKENED
BY WATER LEAKAGE

If you've a problem of this kind consult

The CEMENTATION COMPANY LIMITED

Works & Offices: BENTLEY WORKS, DONCASTER. Telephone: 54175 & 54136 (8 lines)
Head Office: 20 ALBERT EMBANKMENT, LONDON, S.E.11. Telephone: RELiance 7654 (15 lines)

CUT YOUR CONCRETE COSTS

with the

A.B.MOULD

MIXER-DRIVE SHOVEL

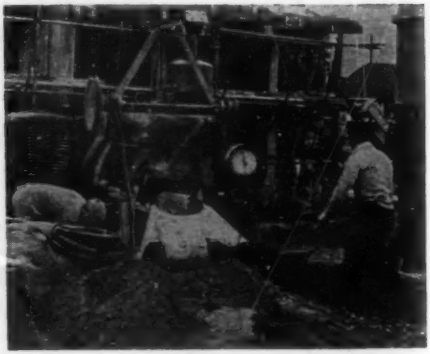
ALL BRITISH DESIGN AND MANUFACTURE

(Patent applied for)

At last !

The perfect combination of a winch unit attached to and driven by the mixer, but operated from the press-button-controlled shovel.

THE BUILT-IN JIB ELIMINATES SITE INSTALLATION COSTS.



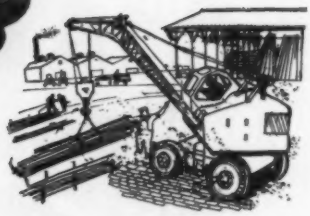
LOW CAPITAL OUTLAY RECOVERED IN TEN WEEKS
NO RUNNING COSTS
FITTED TO MOST MIXERS

Ask for a demonstration from :

A. B. MOULD & CONSTRUCTION CO., LTD.

VULCAN WORKS, VULCAN WAY
NEW ADDINGTON, SURREY

Telephone : Lodge Hill 2347 *Telegrams : Abmould, Croydon*



FORD POWER for industry

Ford industrial engines are a practical proposition for many industrial equipments . . . **compressors, cranes, pumps, contracting equipment, earth borers, generators, railcars, welding plant, works trucks, tractors and conversions.** Simple design, modern flow-line production methods and common interchangeable parts contribute to the low cost of these high efficiency engines. And remember, *every* Ford engine is fully backed by a World-wide Spare Parts Service Organisation.

Take your choice from a wide power range . . . Diesel 30 to 86 b.h.p. and Petrol 21 to 87 b.h.p. (12-hr. rating).

DIESEL ECONOMY—have you considered the replacement of existing power units in your equipment and trucks with the famous Ford 4D Diesel engine? You'll have the unique advantages of economy, long-life and low running costs . . . plus the best service in the World !

Wherever you are, whatever your problem, we are at your service. For further details of

FORD INDUSTRIAL ENGINES

and the equipments they power, contact your nearest Ford Dealer or write to

FORD MOTOR COMPANY LTD · PARTS DIVISION · AVELEY DEPOT · SOUTH OCKENDON · ROMFORD · ESSEX · ENGLAND

A drop of Evoset

Makes it June in December as far as I am concerned

Even when there was a smell of frost we used to have to pack up. But nowadays we go on with concreting, screeding, rendering and brick laying even when the bottom of the thermometer seems likely to fall out. We just add a drop of Evoset to all our cement and concrete mortar gauging fluids and carry on . . . frost does not mean a thing!

Evoset not only gives complete frost protection and enables building to be carried on in the severest weather, it waterproofs, speeds up setting, reduces gauging water and improves strength. Since the cost is very little, these four extra properties make the addition of Evoset a money and labour saving proposition in any weather.

This brochure explains the economics of Evoset; write today.

EVOSET—
all set in any weather

Pin business card here

NAME .....
ADDRESS .....
.....
COMPANY .....

Evoset literature will be sent by return.

8

A DIVISION OF EVODE OF STAFFORD

EVODE LTD. (Building Chemicals Division),
Common Road, Stafford. Tel.: 2241 (5 lines)
London Office: 1, Victoria Street, S.W.1. ABBey 4622/3

borsari TILE-LINED CONCRETE TANKS

for storage of fuel oil diesel oil petrol and industrial liquids

We invite inquiries for the construction of tile-lined concrete storage tanks of any shape, size or capacity, in any part of the world. These tanks require no lagging and no maintenance, and have been in use for over 50 years. Many references available in the United Kingdom and on the Continent. Immediate attention given to all inquiries. Estimates and representative's visits free of charge and without obligation. Full details supplied on request.

BORSARI & CO

ZOLLIKON-ZURICH
SWITZERLAND
ESTABLISHED 1873

B

Steel Reinforcement

. . . bent . . . bundled . . . labelled

Delivered to site ready for fixing • No loss of time in checking and sorting material • No loss of material due to prolonged storage on site •

A comp' te service of
DESIGN, FABRICATION AND FIXING
for all types of Reinforced Concrete Construction.

T. C. JONES
AND COMPANY LIMITED

REINFORCEMENT ENGINEERS

HEAD OFFICE: WOOD LANE, LONDON, W.12 · *Telephone: SHEpherds Bush 2020*
SOUTH WALES OFFICE:
2 PIERHEAD CHAMBERS, BUTE STREET, CARDIFF · *Telephone: Cardiff 28786*
REINFORCEMENT DEPARTMENT:
17 BUCKINGHAM PALACE GARDENS, LONDON, S.W.1 · *Telephone: SLOane 5271*
WORKS: Shepherds Bush, London. Neasden, Middlesex. Treorchy, Glamorgan

THE 600 GROUP OF COMPANIES

All reinforcement enquiries please, to: 17 Buckingham Palace Gardens, London, S.W.1

544/3P11

TELECRETE

HYDRAULIC CONCRETE TIPPER

Designed for strenuous full-time work on all kinds of building sites, the Telecrete has been proved both efficient and economical for transporting ready-mixed concrete from a central mixing plant. The sturdy hydraulic controls are easy to operate. Ideal for public works contractors.

Illustrated literature available on request.

TELEHOIST LIMITED

TELEHOIST WORKS · CHELTENHAM · GLOS

Land-Rover leads...

Specifically designed for use in industry and agriculture

Introduced in 1948, the 4-wheel drive Land-Rover has won a world-wide reputation for toughness and reliability. In industry, the versatile Land-Rover takes labour, stores and machinery to remote, roadless sites and tackles the toughest assignments with good-humoured ease. On the land, it is indispensable for carrying loads, towing, ferrying men and materials about the farm, and as a source of mobile or stationary power capable of operating all kinds of machinery.

The fact that it has also been called up in its thousands for service with the armed forces of the free world is a remarkable tribute to Rover engineering and to the Land-Rover's road and cross-country performance.

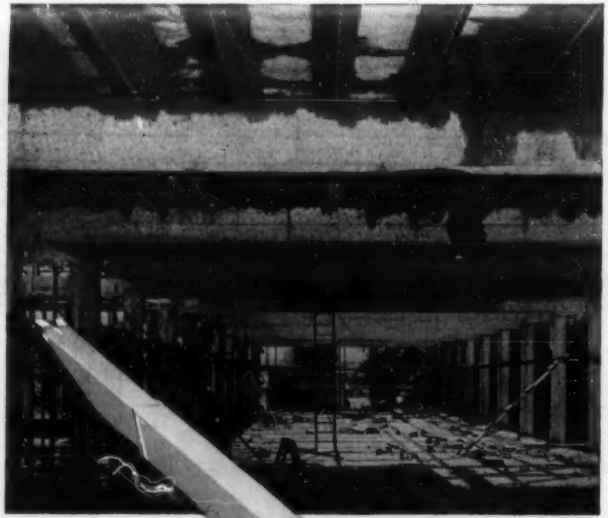
There's no substitute for the 4-wheel drive PETROL or DIESEL

LAND-ROVER

By Appointment to Her Majesty Queen Elizabeth II Manufacturers of Land-Rovers The Rover Co. Ltd.

THE ROVER COMPANY LTD · SOLIHULL · WARWICKSHIRE and DEVONSHIRE HOUSE · PICCADILLY · LONDON

CVD-196



TRIANCO
TELESCOPIC
CENTERS

THE ORIGINAL TELESCOPIC SHUTTERING used by LEADING CONTRACTORS

Spans from 2′ 10½″ to 16′ 6″ at competitive prices.
Speedy to erect and dismantle.
Simple to handle—no skilled labour required.
Safe to use—combined with light weight.
Saving of Timber.

An efficient and economical shuttering for hollow block and suspended reinforced concrete floors.

The lightness in weight of these Centers in no way impairs their strength owing to the triangular design, which feature provides ample strength and at the same time facilitates handling on site.

Write for particulars to:

TRIANCO LIMITED.

TRIANCO LTD. Imber Court, EAST MOLESEY, Surrey
Telephone: EMBerbrook 3300 (4 lines)
Telegrams: TRIANCO, EAST MOLESEY

Those URGENT jobs!

If you want to use concrete in less than 24 hours you must use Fondu

When it's a question of usable strength at real speed no other type of cement can approach CIMENT FONDU.
Many concreting jobs can be put into use even in a few hours; 24 hours is the *maximum* waiting time.
CIMENT FONDU is not "quick-setting" and gives ample time for placing; considerable strength develops after about 6 hours.

Please ask for leaflet "Between Dusk and Dawn".

CIMENT FONDU
Regd. Trade Mark
ALUMINOUS CEMENT

The Cement for Industry

FOR SPEED · STRENGTH
RESISTANCE · REFRACTORINESS

Manufactured by

LAFARGE ALUMINOUS CEMENT COMPANY LIMITED
73, BROOK STREET, LONDON, W.I. Telephone: MAYfair 8546

UNI-TUBE
PLIABLE STEEL TUBING

Ducts for stressed concrete . . . labour saving . . . easy to install . . . outer ribbing gives a perfect bond to the surrounding concrete . . . the inside of the tube is smooth to facilitate the passage of bars or cables and allows free flow of grout.

Supplied in ⅜" up to 6" i.d.

As approved and supplied for the Lee–McCall, Freyssinet and Gifford–Udall systems. Also suitable for other systems and designs.

FOR STRESSED CONCRETE

UNI-TUBES LTD *Enquiries to London Office :*

1-2 Langham Place, W.1 **Telephone : Langham 4887-8-9**

Works : Alpha Street, Slough. **Telephone : Slough 25476-8**

Supplied to leading contractors throughout the world.

THE NEW CODE OF PRACTICE 114 : 1957

is printed in full in

"Explanatory Handbook on the British Standard Code of Practice for Reinforced Concrete No. 114: 1957"

By W. L. SCOTT, M.I.C.E., W. H. GLANVILLE, C.B., C.B.E., D.Sc., M.I.C.E. AND F. G. THOMAS, PH.D., B.Sc., M.I.C.E.

A new edition of this authoritative work is now ready. The requirements of the Code are explained in detail, and numerous diagrams and tables are now given for design by the load-factor method as well as by the elastic theory.

ORDER FORM

To
CONCRETE PUBLICATIONS, Ltd.,
14 DARTMOUTH STREET,
LONDON, S.W.1, England.

Please send ..... * copy/copies of

"Explanatory Handbook on the B.S. Code of Practice."

*Price 12*s.* 6*d.*; 13*s.* 6*d.* by post. 3 dollars in Canada and U.S.A.

A remittance for ..... is enclosed.

BLOCK CAPITALS PLEASE

NAME .....

ADDRESS .....

.....

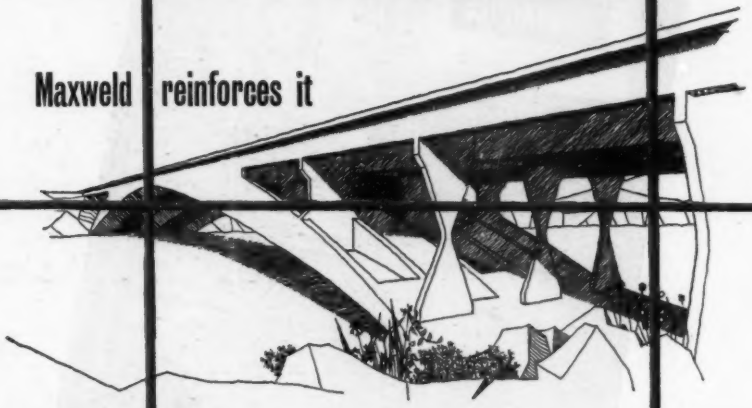
.....

Remittances from Canada and U.S.A. may be made in the ordinary way by drawing a check on the customer's bank made payable to Concrete Publications, Ltd., in dollars and cents or by International Money Order obtainable at a Post Office.

. . . this NEW PUBLICATION gives the solution to most foundation problems send for your copy NOW!

FRANKIPILE THE FRANKI COMPRESSED PILE CO. LTD · 39 VICTORIA STREET · LONDON · SW1

Maxweld reinforces it



All over the world, MAXWELD reinforces it: concrete and brickwork, in roads, locks, factories, docks, bridges, spas and reservoirs. *Do you need reinforcements? Call up the MAXWELD man!* He'll tell you all about MAXWELD fabric — made to BSS 1221 Part A, closely controlled for quality from raw material onwards, available for quick delivery anywhere. He'll tell you what type you need, how much you need, and how much it's going to cost you. He's backed by *Richard Hill's Design Service*, always ready to work out detailed plans and estimates. Call up the MAXWELD man— at Middlesbrough, London, Birmingham, Manchester, Leeds, Bristol and Glasgow.

Maxweld fabric

is manufactured by **RICHARD HILL LIMITED** (Established 1868)

Newport Wire and Rolling Mills, Middlesbrough, Yorkshire. Tel: Middlesbrough 2206

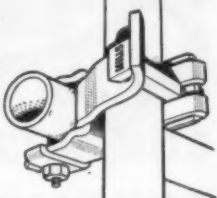
A MEMBER OF THE FIRTH CLEVELAND GROUP FC

CRC IM3

Mills Scaffold Structure at the Esso Refinery, Fawley.

MILLS Steel Scaffolding

For rapid assembly, economy and sheer strength, builders all over the world use Mills Steel Scaffolding. Mills standard steel tubing has a high strength-to-weight ratio, giving firm support with maximum safety (it complies with B.S. 1139-1951). The Mills 90° Clip is simply designed to speed erection. It is fastened with a few turns of a ½" spanner—the only tool required for the whole range of Mills fittings. The Mills 90° Clip gives greater grip as load increases, keeping scaffolding framework rigid and completely safe.



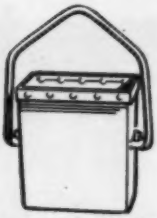
MILLS SCAFFOLD CO. LTD. *A subsidiary of Guest, Keen & Nettlefolds, Ltd.*
Head Office: Trussley Works, Hammersmith Grove, London W.6 (Riverside 3011)
Depots: BIRMINGHAM · BOURNEMOUTH · BRADFORD · BRIGHTON · BRISTOL CANTERBURY · CARDIFF · COVENTRY · CROYDON · HASTINGS · HULL · ILFORD LIVERPOOL · LONDON · MANCHESTER · MIDDLESBROUGH · NEWCASTLE · PLYMOUTH PORTSMOUTH · PRESTON · READING · SHEFFIELD · SOUTHAMPTON · SWANSEA

ABELSON for SKIPS

Circular tipping skips ¾ cu. ft. to 2 cu. yd.

Concrete pouring skip side discharge 10 cu. ft. to 27 cu. ft.

Circular controlled discharge bottom dump skips ½ cu. yd. to 1 cu. yd.



Square tunnelling or trenching skips. 4-fifths cu. ft. capacity.

Rollover skips ¼ cu. yd. capacity.

Boat skips 3 cu. ft. to 7 cu. ft.

Concrete pouring skips bottom discharge 10 cu. ft. to 27 cu. ft.

Special and non-standard skips manufactured to your specifications.

ABELSON & CO. (ENGINEERS) LTD.

SHELDON
BIRMINGHAM 26
TEL: SHELDON 2424 (10 lines)

Model VP 350-A (Swivel Base or Barrow Hounting)

Prompt Delivery. Highly Competitive Prices. Genuine Service. Re-Sale Terms Available.

For Greater Strength, Firmer Bonding and Better Surfacing of Concrete—

"BAXTUL"

Regd. Trade Mark *British Made*

Extra-High Frequency

INTERNAL CONCRETE VIBRATORS

- The model illustrated here operates 9,000 to 15,000 Vibrations per minute from low flexible shaft speeds of 4,500 to 7,500 R.P.M.
- Petrol or Electric Drive.
- Robustly built throughout and backed by genuine service.
- Fitted centrifugal clutch, long-life flexible drive and Vibrator.

This unique machine, with quick-change additional tools, can also be used for: SURFACING, WET-RUBBING CONCRETE, GRINDING, DISC SANDING, AND DRILLING (up to 1½" in Concrete, 1" in Steel, and 2" in Wood).

★ *We operate a 48-hour Shaft Repair Service for all makes. Write to-day for 8-page fully descriptive Catalogue.* Agents throughout the world.

30 years' experience in the design and manufacture of flex-shaft tools.

THE FLEXIBLE DRIVE & TOOL CO., LTD.

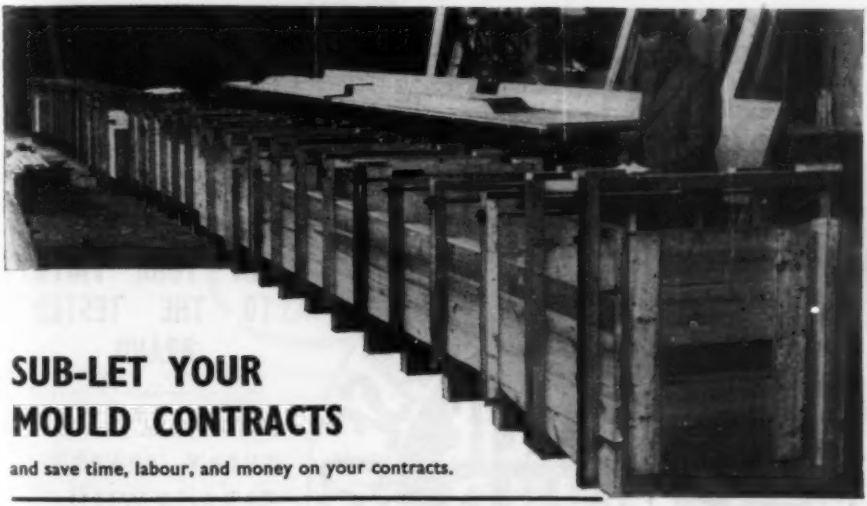
EDENBRIDGE, KENT. *Telephone:* 3385–6

LONDON OFFICE: 17 QUEENSBERRY WAY, S.W.7. *Telephone: KENsington* 3583

WOODEN *TROUBLE-FREE* MOULDS

delivered to the site ready for use

The mould illustrated below was supplied by us to Concrete Development Co., Ltd., for producing 75-ft. precast reinforced concrete posts for Messrs. Holland & Hannen and Cubitts, Ltd.



SUB-LET YOUR MOULD CONTRACTS

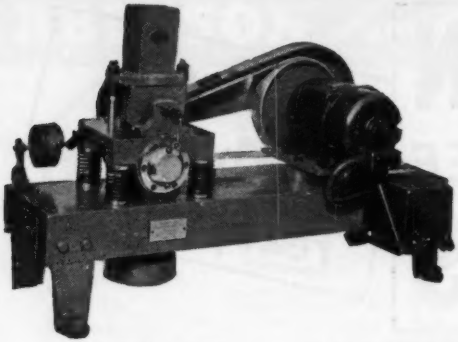
and save time, labour, and money on your contracts.

moulds for all precast structural members and other concrete units

An exacting service for the supply of wooden moulds is now available to all Contractors engaged in producing on the site precast concrete for frame structures and other types of buildings. We are fully equipped to produce moulds to your design—however intricate—for all classes of precast concrete, which we guarantee to be accurate in every detail and strongly constructed to give the maximum number of castings. Economical prices and early delivery assured for contracts in any part of the country. We also specialise in the supply of ready-to-use timber shuttering to any design.

MAY & BUTCHER LTD

HEYBRIDGE BASIN, MALDON, ESSEX. TELEPHONE: MALDON 698



For compacting mortar cubes for compression tests in

B.S.12/1947, 915/1947, 146/1947, 1370/1947.

Automatic control

"CAPCO"

H.F. VIBRATOR

"CAPCO" CONCRETE TESTING APPARATUS also includes: Cube Moulds; Slump Cones; Tensile, Vicat and Cylindrical Moulds; Compacting Factor Apparatus—Standard and Automatic; Sieve Vibrators and Sieves; etc.

CAPCO (SALES) LTD., BEACONSFIELD RD., LONDON, N.W.10

'Phone: WILLESDEN 0067/8 Cables: CAPLINKO, LONDON

THE LEEDS OIL & GREASE CO. · CHADWICK·ST. LEEDS ·

CONCRETE MOULD OIL

PIN YOUR FAITH TO THE TESTED BRAND.

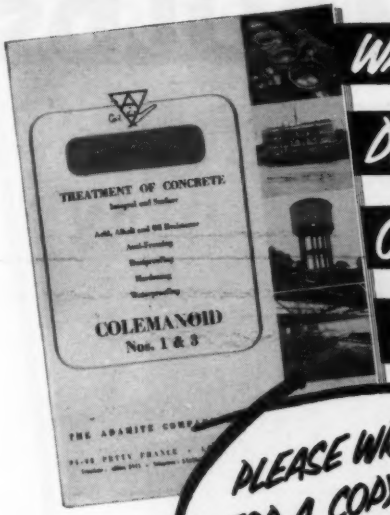
THIS LABEL ON EVERY BARREL CARRIES WITH IT FIFTY YEARS' EXPERIENCE OF MANUFACTURE.

NONE OTHER IS "JUST AS GOOD"

THE LEEDS OIL & GREASE CO.

Phone 22480 LEEDS, 10 'Grams: "Grease."

Interesting and Useful Information about Concrete



WATERPROOFING
DUSTPROOFING
OILPROOFING
HARDENING

PLEASE WRITE FOR A COPY OF OUR BROCHURE

Colemanoid was used to waterproof this retaining wall of the Daily Express building, in Fleet Street.

Colemanoid is a liquid chemical compound which when added to the gauging water will increase the compressive and tensile strength of the concrete by as much as 35%. It will also proof it against oil, water, damp, dust and frost. In certain situations—garages, boiler surrounds, machine shops—oilproof concrete is essential. Colemanoid is your answer—so quick—so effective.

COLEMANOID

A Product of the Adamite Company Ltd.

94-98 PETTY FRANCE, LONDON, S.W.1 ABBEY 9511

RANALAH
STEEL MOULDS

MANGER MOULDS

Solidly constructed Standard Moulds of many types from stock or specially made to your drawings. Speedy and competitive. Kerb, Garden Edging, and Coping Moulds to B.S. 340–1950. We make a speciality of the prompt delivery of radius kerb moulds. Other moulds ex stock or in a few days. Send for illustrated catalogue of standard moulds. Accurate and very strongly made.

RANALAH
STEEL MOULDS LIMITED

THE HYDE, LOWER BEVENDBAN, BRIGHTON, 7. Tel: 62216

FORMCRETE

at Wimbledon

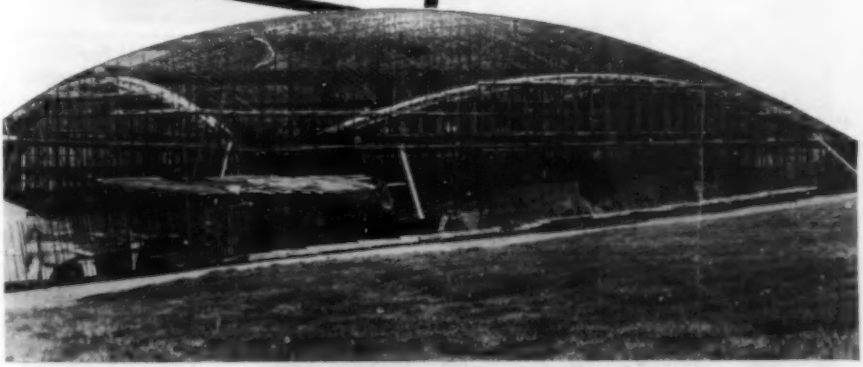
A UNIQUE CONSTRUCTIONAL PROJECT NOW BEING UNDERTAKEN BY GAZES IN CONJUNCTION WITH THEIR REINFORCED CONCRETE SUBSIDIARY COMPANY—FORMCRETE LTD.

As can be seen in the photograph below, the construction of the prestressed concrete dome which is to cover two of the hard tennis courts at the All-England Lawn Tennis & Croquet Club, Wimbledon, has now reached the stage where the overall shape is apparent.

At the moment, the entire roof area is covered by scaffold-tube formers, which in turn will be covered by expanded metal that will constitute the formwork.

The shape of the bow-string girders can also be seen connecting to one of the four corner columns which carry the whole weight of the structure

Enquiries are invited by W. H. Gaze & Sons for all types of building and specialist concrete construction.



THE CONSULTING ENGINEERS FOR THIS WORK ARE C. J. PELL & PARTNERS
ASSISTANT IN CHARGE J. BORROWSKI

FORMCRETE LTD. *REINFORCED CONCRETE SPECIALISTS*

One of the GAZE group of companies

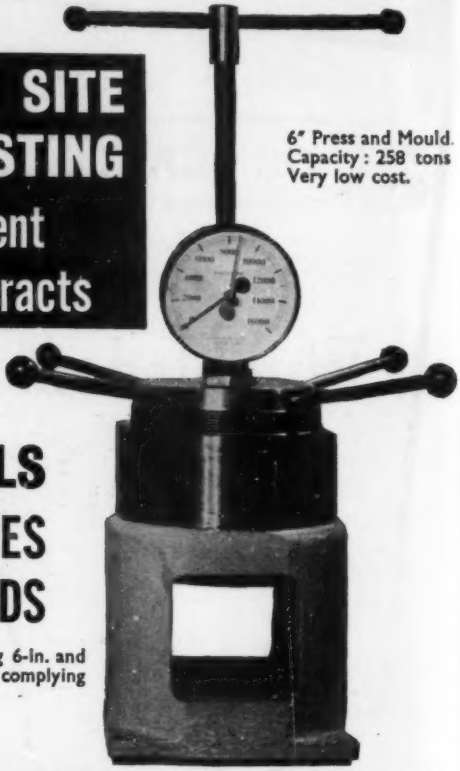
19-23 HIGH ST., KINGSTON-ON-THAMES, SURREY. TEL.: KIN 1144

LONDON — KINGSTON — SOUTH AFRICA

C

APPROVED FOR SITE CONCRETE TESTING

on all Government Departments' Contracts



6" Press and Mould.
Capacity : 258 tons
Very low cost.

MILBANK - WELLS HYDRAULIC PRESSES AND CUBE MOULDS

Presses and moulds in the two sizes for testing 6-in. and 4-in. cubes up to 16,000 lb. per square inch, complying with B.S. 1881.

4" Press and Mould.

Essential for Prestressed Concrete Work

in use all over the world for concrete testing

Full details and prices sent on request.

MILBANK FLOORS LTD.

PRESTRESSED CONCRETE CONSTRUCTION

RIVER HOUSE, EARLS COLNE, ESSEX. Tel. : Earls Colne 410

Manufactured for us by Horner & Wells, Ltd., Engineers, Chelmsford, Essex.

Prestressed Concrete Duct Grouting

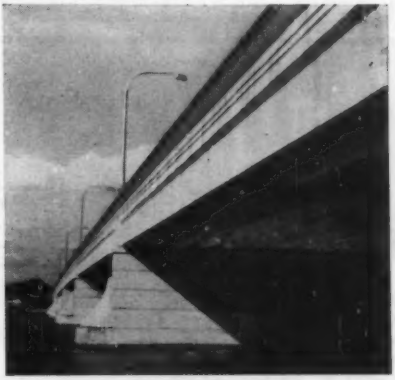
NORTHAM BRIDGE · SOUTHAMPTON

Precast Sections Prestressed together by Freyssinet System and Cable Ducts Colgrouted

Consulting Engineers: Rendel, Palmer & Tritton.

Contractors : Christiani & Neilsen Limited.

Mobile Grouting Units with skilled operators are available in the United Kingdom at a fixed daily charge. Upwards of 60 ducts usually grouted per day on site.



Colcrete Equipment is used extensively for the grouting of Post Tensioned Prestressed Concrete Cable and Bar Ducts. Both horizontal and vertical ducts can be filled completely and sealed off under controlled pressures of up to 125 p.s.i. using sanded grout or expansile cement slurry or low water/cement ratio.

*

PLANT SOLD OVERSEAS

COLCRETE LTD.

GUN LANE · STROOD · KENT · Tel.: Strood 78431-2-3

GLASCRETE

at

St. Basil's Church

BASILDON

Architects

Messrs. Burles & Newton

A.A.R.I.B.A., A.M.T.P.I.

●

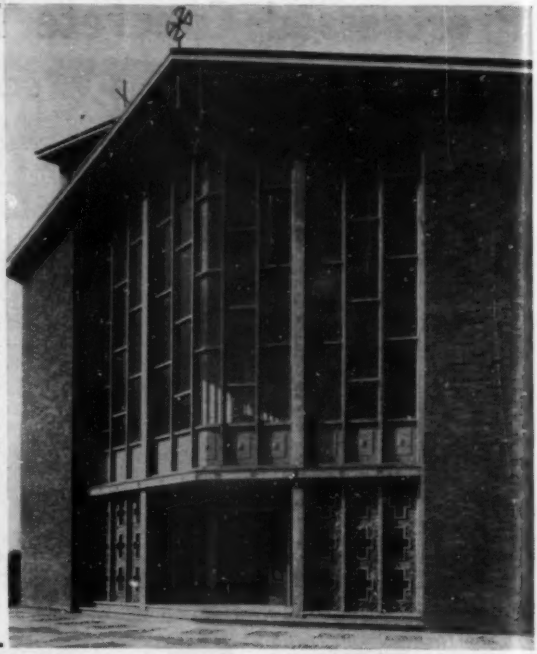
The entire natural lighting to this church is provided by Glascrete windows of which this end feature is an interesting example. Concrete Tracery to the baptistery and doorways further illustrates the adaptability of Glascrete.

●

J. A. KING & Co LTD

181 QUEEN VICTORIA STREET

LONDON, E.C.4. CEN. 5866



COPPER STRIPS

for expansion joints

All Reinforced Concrete Engineers recognise the advantages of using copper strips for sealing joints in concrete work. Copper is ductile, will not crack under repeated banding, is non-corrosive and is unaffected by wet concrete. We specialise in the supply of perforated copper strips of all required lengths and widths for expansion joints, and shall be pleased to submit prices against detailed specification.

ALEX J. CHEETHAM LTD.

MORTON STREET · FAILSWORTH · MANCHESTER

Telephone: FAILsworth 1115/6

McCALLS MATOBAR

WELDED FABRIC REINFORCEMENT FOR ROADS

IN IRAQ

BAGHDAD ROAD CONTRACT

Contractors:—The United Contracting Co. Ltd., Baghdad

McCALL & CO. (SHEFFIELD) LTD. P.O. BOX 41 SHEFFIELD

Telephone: Rotherham 2076 (P.B. Ex. 8 lines).
London Office: 8–10 Grosvenor Gardens, S.W.1. Telephone: Sloane 0428.
Birmingham Office: 83 Kineton Green Road, Olton, Solihull. Telephone: Acocks Green 0229.
Portsmouth Office: 23 & 25 Spur Road, Cosham. Telephone: Cosham 78702.

S.R.B.67

Roadworthy . . .

Also . . . approachworthy, runwayworthy, constructionworthy *wherever concrete is used.* In all cases, the word for jointing is — Crecel Expansion Jointing. Comprising a cellular-type non-extruding filler and a poured rubber-bitumen sealing compound, Crecel Jointing meets with the requirements of the Road Research Laboratory. In just one word Crecel is *specificationworthy.*

RUBEROID

ROAD MAKING MATERIALS

For technical literature write to :—
THE RUBEROID COMPANY LIMITED,
187 COMMONWEALTH HOUSE, 1-19
NEW OXFORD STREET, LONDON, W.C.1

CE0018

Reinforced Concrete
DESIGN AND CONSTRUCTION

Cast Stone
AND PRECAST CONCRETE

Floors
IN SITU AND PRECAST

Granolithic Pavings

Staircases
IN SITU AND PRECAST

STUART'S
GRANOLITHIC CO. LTD.
FOUNDED 1840

LONDON
105 Baker Street, W.1.
Telephone : Welbeck 2525/6.

EDINBURGH
46 Duff Street.
Telephone : Edinburgh 61506.

BIRMINGHAM
Northcote Road, Stechford.
Telephone : Stechford 3631/2.

MANCHESTER
Ashton Road, Bredbury, Stockport.
Telephone : Woodley 2677/8.

IT'S HERE AT LAST!

The **PORTABLE**

DENISON

COMPRESSION TESTING MACHINE

for tests on concrete cubes, cylinders, etc

- *Ideally suitable for use on construction sites.*
- *Easily portable— weighs only 3½ cwt.*
- *Compact—less than 3 feet high.*
- *Capacity 150 tons by increments of ¼ ton.*
- *Convenient controls including load pacer.*

Write for further details now

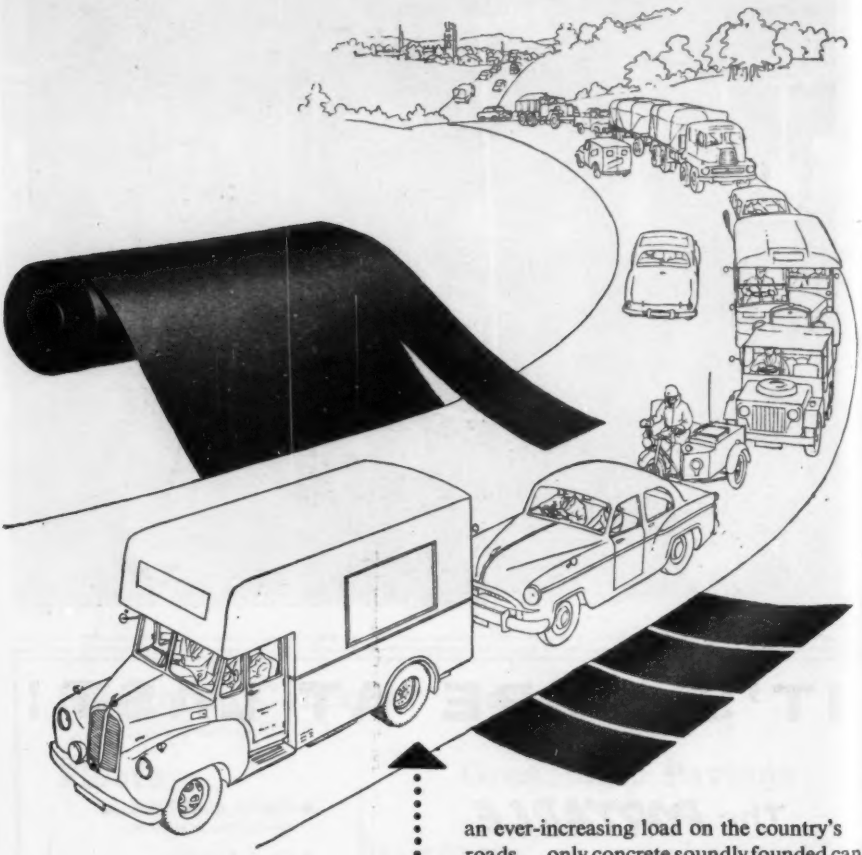
SAML. DENISON & SON LTD

HUNSLET FOUNDRY · MOOR ROAD · LEEDS 10

Tel : Leeds 7-5488 Grams : 'Weigh Leeds 10'

Area Offices at

LONDON	BIRMINGHAM	NORTH-WEST	NORTH-EAST
SLOane 4628	Midland 3931	Blackfriars 1986	Leeds 2-8433



The traffic rolls...

an ever-increasing load on the country's roads... only concrete soundly founded can stand up to it. That's why you'll see more and more IBECO used on road construction and repair jobs. It's tough, it improves strength, it lengthens the life of the road and it saves money. We'll be glad to send you samples.

C. Davidson & Sons Ltd., Mugiemoss, Aberdeenshire.

WATERPROOF CONCRETING PAPER

No. 8 IN A SERIES SHOWING TECHNICAL DEVELOPMENTS IN CONCRETE CONSTRUCTION

JOHN HEATHCOAT'S WEAVING SHEDS

TIVERTON, DEVON

Prestressed concrete

decreases costs in factory construction

Sponsor: JOHN HEATHCOAT & CO. LTD., TIVERTON, DEVON.

Architect: ALEC FRENCH, F.R.I.B.A., BRISTOL.

Design by: STRESSED CONCRETE DESIGN LTD., LONDON, S.W.4.

Contractors: WM. COWLIN & SON LTD., BRISTOL.

Heathcoat's factory at Tiverton, Devon, has recently been extended using prestressed concrete valley beams and northlight roof trusses. The first section uses six beams of 56 ft. span. The second phase consists of 14 beams arranged in two 50 ft. spans. The third and last section uses 10 beams of 108 ft. span.

* *Some further details of this project and others are published in brochure form. Write for your copy now.*

Ever since prestressed concrete construction was first used in this country, designers, architects and civil engineers have specified "Wire by Johnsons." The reason is quality, built up on early experimental work with those specialist designers who studied and worked on the Continental development of this new building technique.

Johnsons have a long record of "Firsts" including indented wire for greater bonding and coils of 8 ft. diameter, from which the wire pays out straight.

wire was essential-

Johnsons of course!

Richard Johnson & Nephew Ltd., Manchester 11 Telephone: East 1431

STENT

PRECAST CONCRETE PILES

Preferred by constructional engineers for their unchanging supremacy, Stent Precast Concrete Piles have proved their qualities wherever used.

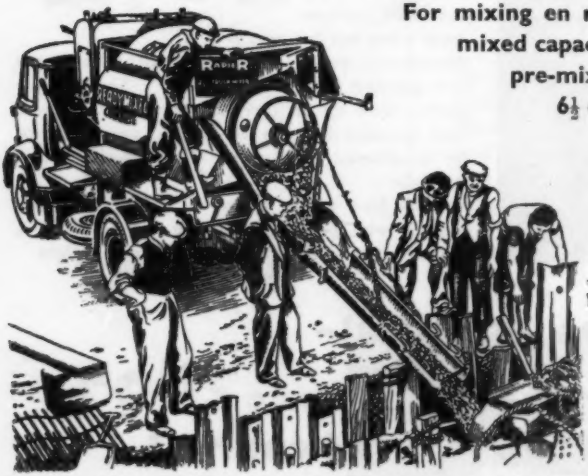
AVAILABLE FOR IMMEDIATE DELIVERY

May we forward full details

STENT PRECAST CONCRETE LTD. Sales Office: 1 Victoria Street, London, S.W.1 Tel. : Abbey 2573
Hd. Office & Works: Dagenham Dock, Essex Tel: Rainham (Essex) 780

RAPIER TRUCK MIXERS and AGITATORS

For mixing en route 2½ and 4½ cu. yd. mixed capacity. For agitating pre-mixed concrete 3¾ and 6½ cu. yds.



Also makers of a full range of tilting and non-tilting mixers and self-priming water pumps.

RAPIER
EXCAVATORS
MOBILE CRANES
CONTRACTORS PLANT
WATER CONTROL
RAILWAY
PLANT

RANSOMES & RAPIER LTD · IPSWICH · ENGLAND

Contractors: Messrs. William Cowlin & Son Ltd.

The factory and warehouses of The Metal Agencies Company Limited are a masterpiece of good planning and excellent design: recent extensions have increased the covered area to over 7 acres. For all floor toppings, mass concrete, retaining walls, etc., No. 1 Metallic Liquid has been exclusively used. The concrete floors have been made hard, dustless and waterproof and capable of withstanding exceptionally heavy wear and tear; whilst the foundations and retaining walls have been made thoroughly waterproof. For over 40 years No. 1 Metallic Liquid has been consistently specified by Architects and Contractors. It is the only admixture SOLD UNDER GUARANTEE.

From **5/-** per gallon

Special prices for large contracts

WRITE NOW FOR BOOKLET 56 GIVING FULL DETAILS

Lillington's
NO. 1 METALLIC LIQUID

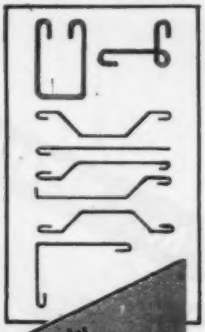
GEORGE LILLINGTON & CO. LTD.
WILLOW LANE, MITCHAM, SURREY

Tel: Mitcham 1066
For Scotland: 42 High Street, Greenock. Tel: Greenock 20175

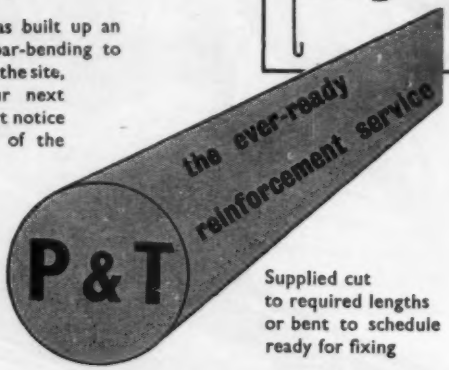
AP2394

REINFORCING BARS

plus bending service if required



The P. & T. Reinforcement Service has built up an excellent reputation for accuracy in bar-bending to schedules, reliability, prompt delivery to the site, and economy. Consult us for your next contract. Quotations submitted at short notice for contracts of all sizes in any part of the country.



PASHLEY & TRICKETT LTD

STOKE STREET • SHEFFIELD, 9

TELEPHONE: 41136-7

Supplied cut to required lengths or bent to schedule ready for fixing

---

WATERTIGHT LININGS FOR RESERVOIRS, SWIMMING BATHS, ETC.

LININGS FOR TUNNELS, SEWERS, TANKS.

Specialists in the Repair and Reconditioning of Reinforced Concrete Structures, etc.

THE

GUNITE

CONSTRUCTION CO. LTD

WESTERN HOUSE, HITCHIN, HERTS.

Telegrams: Gunite Hitchin

Telephone: Hitchin 4371

PRESTRESSED CONCRETE CONSTRUCTION

McCalls Macalloy Bulletins comprise reproductions of authoritative articles from the technical press giving up-to-date information about the application of Lee-M Call prestressed concrete.
Copies of the latest Bulletins listed below are available on request.

BULLETIN No. 11.
Prestressed Concrete Bridges in North Devon.

BULLETIN No. 12.
New Gandy Bridge, Tampa Bay, Florida.

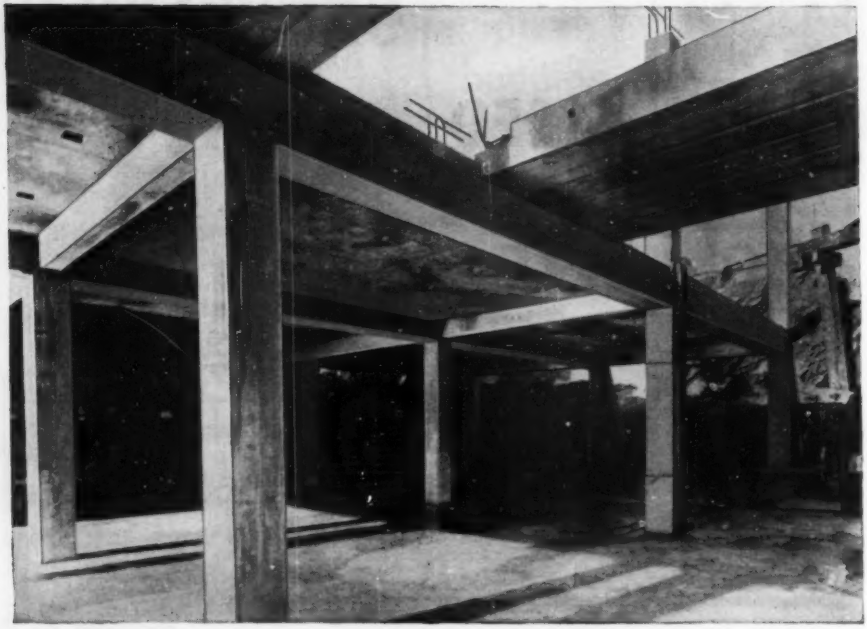
BULLETIN No. 13.
Pipe Bridges in Lee-McCall Prestressed Concrete.

BULLETIN No. 14.
Mahi Bridge at Vasad.

McCALLS MACALLOY LIMITED

TEMPLEBOROUGH, SHEFFIELD P.O. BOX 41 Tel : ROTHERHAM 2076 (P.B. EX. 8 LINES)
LONDON OFFICE : 8-10 GROSVENOR GARDENS, S.W.1. Tel : SLOANE 0428
Birmingham : 83 Kineton Green Road, Olton, Solihull. Tel : Acocks Green 0229
Portsmouth : 23 and 25 Spur Road, Cosham. Tel : Cosham 78702

PC37



weyroc (REGD) shuttering...

offers concrete advantages

large boards—8′ x 4′ for quick erection

can be used again and again; easily handled

smooth surfaces for best finish

great rigidity with minimum support

For more than ten years Weyroc has been widely used for shuttering. It needs only a simple surface dressing to fit it for repeated use.

weyroc—*one of the world's great man-made materials*

THE AIRSCREW CO. & JICWOOD LTD. WEYBRIDGE, SURREY. WEYbridge 2242/7

Cut your costs with

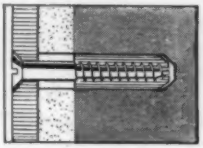
21 RAWLPLUG FIXING DEVICES

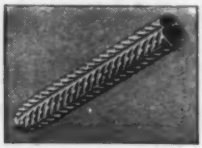
FOR SPEEDY FIXING IN ANY MATERIAL

No more trouble or costly delay because the material was 'difficult'! Whether it's concrete or plastic, breeze or sheet metal, cavity brick or lath and plaster, there's a Rawlplug Fixing Device that makes firm screw or bolt fixings quickly, easily and economically. The speedy answer to every fixing problem is one or other of the 21 different types of Rawlplug Fixing Devices. Write for illustrated brochure.

Screw Fixings

Use the famous RAWLPLUG for neat, firm fixings in brick, stone, etc. All sizes up to ¾ in. diameter Coach Screws. Rawlplugs are waterproof and unaffected by climatic conditions.

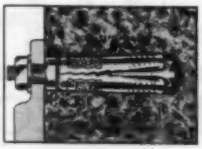




Rawlplug WHITE BRONZE PLUGS are specially suitable when the fixing is subject to very high temperatures, such as the outer brick coverings of furnaces. Use also for under-water fixtures.

Bolt Fixings

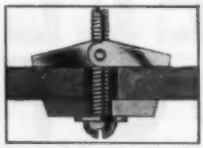
For bolting down machines use RAWLBOLTS, a dry fixing that grips by expansion. No cold chiselling, no waiting for cement to harden. Sizes up to 1 in. bolt diameter.



Use Rawlplug BOLT ANCHORS for bolting down in extremely wet or corrosive situations. Caulking completely seals the anchorage. Use also for anchoring Diesel Generators, Power Hammers, etc.

Cavity Fixings

Screwed up from the front the amazing RAWLNUT forms its own rivet head behind the material — airtight, watertight, vibration-proof, squeak-proof! For all thin or hollow materials.



For ceilings of lath and plaster, plasterboard etc. use Rawlplug SPRING TOGGLES. The inserted Toggle springs open behind the material, spreading the load over a wide area.

USED BY THE MILLION THROUGHOUT INDUSTRY

RAWLPLUG FIXING DEVICES

21 *different types of fixing devices for Speed and Strength*

Made by THE RAWLPLUG CO. LTD., CROMWELL ROAD, LONDON, S.W.7.
The World's largest Manufacturers of Fixing Devices

B559

CONCRETE PROOFING CO. LTD.

GUNITE SPECIALISTS

Expert advice and schemes submitted for gunite work of every kind. Complete information on the various uses of gunite will be gladly sent on request.

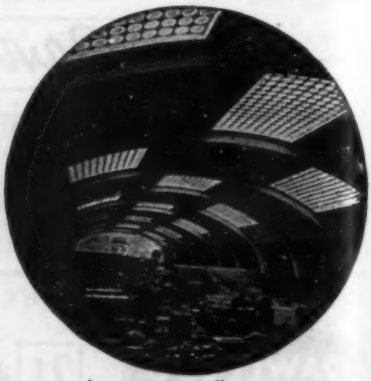
96, Victoria Street, Westminster, S.W.1 Telephone: VICTORIA 7877 and 6275

LENSCRETE

GLASS AND FERRO-CONCRETE

for

SHELL ROOF CONSTRUCTION



LENSCRETE LTD.

66 QUEEN'S CIRCUS LONDON, S.W.8

TELEPHONE: MACAULAY 1063

Agents in all parts of the British Isles, Dominions and Colonies.

operation "reconstruction" at GALLIONS LOCK

CONTRACTOR: JOHN MOWLEM AND CO. LTD.
ENGINEER: G. A. WILSON, ESQ., M.ENG., M.I.C.E., M.I.MECH.E.
CHIEF ENGINEER, PORT OF LONDON AUTHORITY.

In the reconstruction of Gallions Lower Entrance Lock, Royal Albert Dock, John Mowlem and Co. Ltd. used Thamesply Plywood Shuttering for three important reasons: its lightness speeds erection and manhandling; it produced a fine, clean finish; and it can be re-used many times—in this case OVER FIFTY USES, which is not exceptional.

Thames-Celply, the specially impregnated rot- and insect-resistant plywood, is also available for all exterior uses.

JOHN MOWLEM & CO. LTD. once again chose

THAMESPLY

Registered Trade Mark

PLYWOOD SHUTTERING

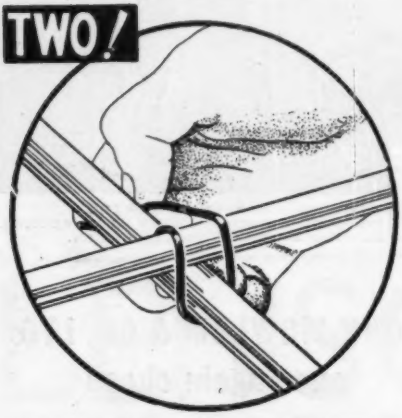
(Phenol Bonded "W.B.P." Test)
W.B.P. means Weather and Boil Proof

Supplied only through the usual trade channels

THAMES PLYWOOD MANUFACTURERS LIMITED

Harts Lane · Barking · Essex · Telephone: RIPpleway 5511

TA5636



'STABIL' BINDERS

ARE GREAT LABOUR SAVERS

In one simple action they fix reinforcing rods as though welded. No slipping. No "fiddling" with wire. No tools to get mislaid. Any workman can use them. Made in all sizes for binding ¼-inch up to 1¼-inch rods. Give "Stabil" Binders a trial and judge for yourself.

● ***SEND TO-DAY for demonstration samples and prices.***

HUNTLEY & SPARKS LTD.

DEBURGH RD., S. WIMBLEDON, S.W.19

Phone: Liberty 2446

COMPLETE PLANTS
DESIGNED • INSTALLED
AND COMMISSIONED

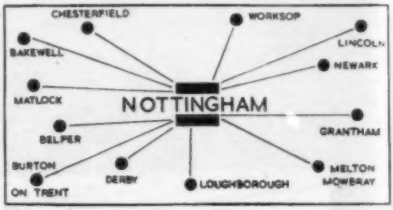
SPECIALISTS IN

Reinforced Concrete • Structural Steelwork • Mechanical Handling Special-Purpose Plant Products Design • Tooling

BRITISH-GECO ENG. CO. LTD.

ADELAIDE HOUSE, LONDON BRIDGE, E.C.4

Telephone : Mansion House, 8277



Trent Gravels

10,000 tons per week

Washed & Crushed 1½ in. to ¼ in.

We are the leading suppliers of high-class concrete aggregates in the area shown above. Prompt deliveries guaranteed and keen competitive prices quoted. Send for samples and prices.

TRENT GRAVELS LTD

ATTENBOROUGH NOTTS

Telephone: Beeston 54255.

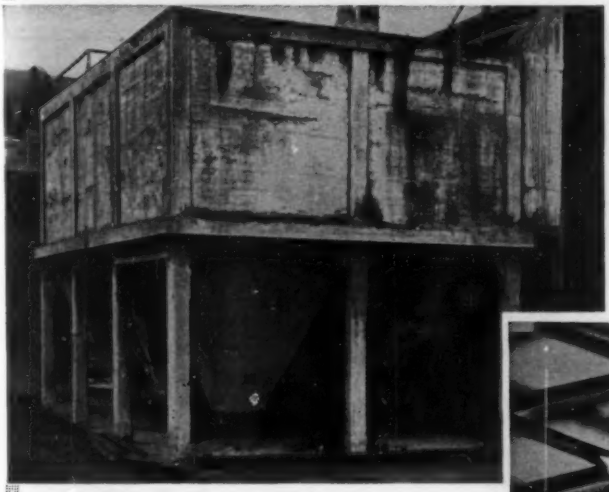
"CONCRETE SERIES"

BOOKS ON CONCRETE

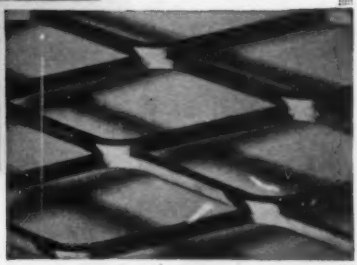
For a complete catalogue giving prices in sterling and dollars, send a postcard to:

CONCRETE PUBLICATIONS, Ltd.
14 Dartmouth St., London, S.W.1
England

These silos were reinforced with EXPANDED METAL



50 years ago



...today's verdict-

EXPAMET can take it!

50 years ago when the Engineers of The Expanded Metal Company pioneered reinforced concrete as a method of construction, they designed and constructed these Raw Meal Silos for The Rugby Portland Cement Co. Ltd. at Southam (at that time Kaye & Co.'s Cement Works). They have given 50 years of constant service.

Today, reinforced concrete is an even better investment and from a rich background of experience, modern developments and techniques in design and supply of reinforcements for all classes of work are available from the

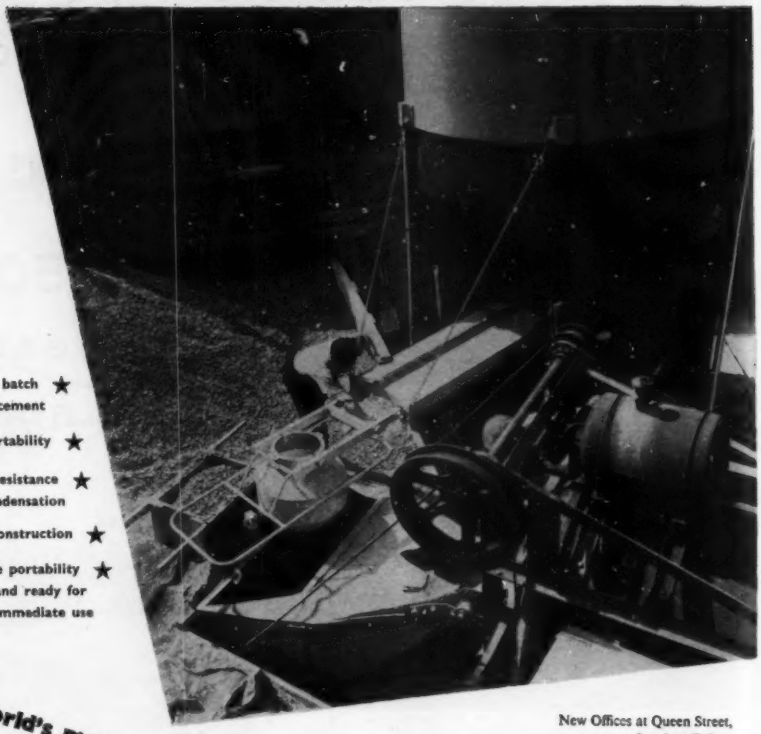
REINFORCED CONCRETE DESIGN GROUP

Chief Design Office: Burwood House, Caxton Street, London, S.W.1. ABBey 7766. Other Group Centres are at: P.O. Box 14, Stranton Works, West Hartlepool. Hartlepools 5531. 118 Portland Street, Manchester. Central 9855. 182-185 Melchett Road South, Kings Norton, Birmingham. Kings Norton 4241.

Expamet

The Expanded Metal Co. Limited
Burwood House · Caxton Street · London · S.W.1
and at

ABERDEEN · BELFAST · CARDIFF · BIRMINGHAM · DUBLIN · EXETER · GLASGOW · LEEDS · MANCHESTER · PETERBOROUGH · WEST HARTLEPOOL



Fully automatic batch weighing of the cement ★

Complete portability ★

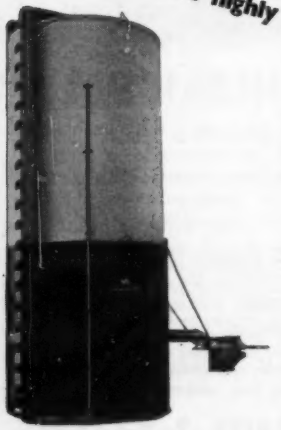
Maximum resistance to condensation ★

Robust construction ★

Complete portability and ready for immediate use ★

New Offices at Queen Street, London, E.C. 4.
Architects: Messrs. Westmore & Partners
Contractor: A. Roberts & Co. Ltd.

The World's most highly developed fully portable bulk cement equipment



Fully proved on hundreds of sites, the Portasilo is the most highly developed, fully portable equipment in the world for handling cement in bulk. The unique Pullwey Mechanical Cement Man provides fully automatic weighing of the cement, without which the full saving of using cement in bulk cannot be achieved. The use of the Portasilo readily effects a saving of 20/- and over per ton of cement used.

PORTASILO REGD LIMITED

Covered by patents or patent applications in Great Britain and the Principal countries of the world

BLUE BRIDGE LANE • YORK • Tel. 24872 (8 lines)
and at LONDON BIRMINGHAM MANCHESTER GLASGOW BELFAST DUBLIN

For handling cement in bulk there's nothing like the Portasilo

CONCRETE AND CONSTRUCTIONAL ENGINEERING

INCLUDING PRESTRESSED CONCRETE

Volume LII, No. 12. LONDON, DECEMBER, 1957.

EDITORIAL NOTES

The Design of Factories.

THE desire to build as cheaply as possible has left little scope for the art of architecture in many modern buildings. The day has gone when business concerns were willing to spend a little extra on the adornment of their headquarters. The greatest possible return on the rentable floor space is now generally the chief consideration of the building owner. The patrons of the art of architecture have largely given way to the speculative builder. Great business concerns and even Government departments often prefer to arrange for developers or financiers to erect and own buildings to suit their requirements and to pay rent to the developer. This tendency of large businesses to rent the buildings in which they conduct their business, and the erection of large office buildings for letting to many tenants by speculators who are concerned only with profit, are the principal reasons for the appearance in our cities of the tall and plain buildings that are the subject of so much adverse criticism. In many cases the architect has become a planner, an organiser, and an economist only, and his art is confined to the spacing of windows and other wall openings and the interior decoration. Another notable feature of modern buildings is their similarity. This again is the result of a desire to save money, and also to the copying in this country of designs and methods of construction that originated abroad. It is possible to turn over the pages of architectural journals and see illustrations of buildings that are hardly distinguishable from one another and that are labelled school, hospital, office, factory, and so on.

Because its purpose is to obtain " attractive and imaginative designs " for a factory, the competition announced on page 410 will be welcomed by all who desire to see a revival of the art of architecture, and the possibility of an architect being able to use his imagination to produce an attractive building rather than using only his wits to produce the cheapest structure that will serve its purpose. It is important that competitors should give much consideration to the requirement for an attractive and imaginative design. It is particularly important that they should give no heed to the claim so often heard that a building that is " functional " and serves its purpose with the utmost economy of materials is necessarily beautiful. Comforting as this fallacy may be to architects who are not also artists, it can be easily shown that functionalism may have little in

common with beauty. In fact they may be opposites. Beautiful and ugly buildings can serve their purpose equally well. Nature recognises no relationship between beauty and utility—an ugly nose may be as good, or a better, organ for smelling than the most beautiful of noses. A factory must, of course, be planned to meet the requirements of the owner and to enable production to be carried on as cheaply and conveniently as possible, and it must stand up and keep out the weather. But when the practical requirements are met the art of the architect has not been exercised—only his skill as a planner and his knowledge of construction. A little extra spent on decoration to make elevations more attractive is well worth while.

The conditions of the competition are notably lacking in restrictions. Detailed calculations are not called for, so that a competitor need not be a skilled computer of stresses. There is no restriction on the number of stories. The products to be made are not specified other than that the factory will be used for what is known as a " light " industry that will employ about three times as many women as men in the factory and twice as many women as men in the office. It is interesting to note that for every eight people employed in production allowance must be made for three people in the office, and that parking accommodation must be provided for fifty cars. Competitors must assume that the building will be erected before its purpose is decided upon, and the design must allow for a change of user. This seems to require an absence of projecting beams.

It is indicated that one of the objects is to " add to the amenities " of an industrial area of a new town or a new housing estate. It is doubtful whether any factory can add to amenities unless it replaces a slum or other eyesore which is not likely to exist in a new town. But one factory can be much more pleasant to look at than another, and here again the promoters are reminding competitors that the purpose of the competition is not solely the production of the cheapest possible structure. It should be borne in mind that concrete as it is left from the shutters does not always weather as well as natural stone, and attention should be paid to the surface finish. A successful method of colouring concrete is that used for concrete roofing tiles, many millions of which have been exposed on roofs in this country for thirty or more years without discoloration. The hue of the " red " roofing tile might not be considered suitable for walls, but the method of producing it might be extended to different hues as a change from exposed-aggregate surfaces.

The requirement that consideration must be given to floodlighting at night raises an interesting architectural problem that has probably never before been considered. The use of projections on a façade to give effects of light and shade when the illumination comes from the sun has been practised from the earliest times. In this competition consideration must be given to the effects of light coming from below or from any other angle. One of the remarkable results of floodlighting is the pleasant effect of light falling on a building from a position never visualised by the architect, and it may well be that experiments with a model will show that the problem is not as difficult as it appears to be. Finally, it is hoped that the competition will produce more than one design that will be acceptable. To many the idea of a " standard " factory repeated all over the country, irrespective of local building traditions, will be as depressing as is the sameness of " council " housing estates and lighting standards.

The Use of High-Tensile Steel Reinforcement.*

By K. HAJNAL-KÓNYI, Dr.Eng., M.I.C.E., M.I.Struct.E.

GENERALLY we are concerned with the safety of structures against collapse under static load. In many cases resistance to fire, to repeated loading, to impact, or to earthquake, is important, whilst safety against blast in the atomic age presents a problem of its own.

SAFETY AGAINST COLLAPSE UNDER STATIC LOAD.

"Standard" Method of Design versus Ultimate-strength Method.

The "standard" method of design used in most countries until recent years is based on the assumption that steel and concrete are both perfectly elastic materials and that the tensile strength of the concrete must be ignored. This method assumes a constant modulus of elasticity for the whole range from zero to the crushing strength of the concrete and to the yield-point or proof stress of the steel, and when either of these values is reached at any section the structure is supposed to fail. In order to provide adequate safety against failure, the stresses due to dead load plus the most unfavourable combination of imposed loads must not exceed a certain fraction of the stress at failure.

In most countries the accepted working stress in bending only was for a long time about one-third of the crushing strength of the concrete and one-half of the yield-point or proof stress of the steel, with an arbitrary upper limit (see previous article). Since the quality of concrete is less reliable than the quality of steel, the working stress in the concrete has to be more restricted than that in the steel. With the working stresses described it was thought that a factor of safety of about 3 was obtained for the concrete and about 2 for the steel. The application of this theory to the design of reinforced concrete was criticised in 1912 by Suenson in Denmark, in 1914 by L. J. Mensch in the U.S.A., and in 1922 by H. Kempton Dyson in this country, and in the 1930's more and more engineers criticised it.

Concrete is far from being an elastic material. Its stress-strain diagram is a curve which, when represented in the conventional manner (with the strain as the abscissa), is concave towards the abscissa. The tangent modulus of elasticity $E_t = \frac{d\sigma}{d\varepsilon}$ (where σ = stress and ε = strain) decreases with increasing stress. Moreover, under sustained load the strain may increase to two or three times its original value, which occurs immediately after the application of the load. Consequently the stress distribution near failure is quite different from that under working loads, and even under sustained load it varies considerably because of shrinkage and creep. Thus the basic assumptions of the elastic theory, namely the linear stress distribution in the compressed zone of the concrete and the similarity of the stress distribution at working loads and near failure, are entirely wrong.

It is obvious, therefore, that the factor of safety cannot be expressed as the ratio of the critical stress in the concrete or in the steel to the working stress. The standard method leads in many cases to the absurd result that a beam with

* Continued from June, 1957.

concrete of a given strength should fail in compression at a certain load because the calculated extreme compressive stress has reached the cube strength of the concrete, when in fact the beam has failed in tension at a substantially higher load. The method is not applicable to prestressed concrete. A further objection to the standard method is that a structure has only one factor of safety.

For these reasons the tendency is to abandon the standard method in favour of the ultimate-load method in which the load causing failure of the structure is determined and a fraction of it as working load, irrespective of " working stresses ", is allowed. The ratio of the ultimate load to the working load is generally called the " load factor ". The advantages of the ultimate-load method, which is applicable equally to structures of materials other than reinforced concrete, are manifold.

(1) It does not necessitate an increase in the resistance to compression when it is known that failure would occur in tension.

(2) It allows flexibility in the magnitude of the load-factor according to the special conditions of a structure. This is not possible with the factor of safety as applied by the standard method which, apart from its anomalies regarding the ultimate load, allows a variation of only the " overall factor of safety ". With the ultimate-load method different load factors may be applied to any of the loads considered.

(3) It brings the design of reinforced and prestressed concrete to a uniform basis.

With the notations used in [12], in which U = ultimate strength of a section, B = effect of basic load, consisting of dead load plus volume change due to plastic and elastic actions, shrinkage, and temperature, L = effect of imposed load plus impact, W = effect of wind load, E = effect of earthquake forces, and K = load factor, the ultimate strength may be expressed as

$$U = K_1B + K_2L + K_3W + K_4E,$$

in which each of the factors K_1 to K_4 may be different according to the circumstances of any particular structure.

The method of design is very relevant to the economical use of high-tensile steel. An assumption common to the standard method and the ultimate-load method is that a loaded beam would fail either in tension or compression, and that other modes of failure such as by shearing, diagonal tension, or bond are excluded. Beams that would fail in compression in the case of bending only are excluded from practical application. A beam designed by the standard method should fail in tension. The limiting percentage at which the permissible stress is reached in both the steel and in the concrete is the so-called " economic " percentage, although it is by no means necessarily the most economical percentage.

According to the standard method, the value of $Q = \frac{M}{bd^2}$ at the " economic " percentage decreases with increasing permissible stress in the steel.* (In this well-known formula M = permissible bending moment in in.-lb., b = width of the compression zone in inches, d = effective depth in inches, and Q = lb. per square inch.) Consequently the depth of a slab or a beam made with a given quality of concrete for a given bending moment has to be greater than the depth required

* The reason for this has been explained in many publications and need not be repeated here.

for mild steel at or near the " economic " percentage. Alternatively, the depth may be maintained but compression steel has to be added. In both cases the possible economical advantage of the use of high-tensile steel on the tension side is reduced or entirely eliminated.

Basic Equation of the Ultimate-load Method for Rectangular Sections with Reinforcement to Resist Tension in Bending Only.

It is not the purpose of this article to explain in detail the load-factor or ultimate-strength method of design, but its basic features should be restated in order to determine the effect on the ultimate moment of an increase of the yield-point or proof stress of the reinforcement. In the first instance singly-reinforced rectangular sections subjected to bending only will be considered. The following notation is used.

n = depth of neutral axis. $n' = \frac{n}{d}$.

c_p = prism strength of concrete. f_c' = cylinder strength of concrete. u = cube strength of concrete.

t_s = tensile stress in steel at failure.

y = yield point or proof stress of steel.

t_u = ultimate tensile strength of steel.

A_s = area of tensile reinforcement.

$T = A_s t_s$ = total tensile force at failure.

C = resultant of compressive stresses.

$p = \frac{A_s}{bd}$.

ε_u = critical strain in extreme face of the concrete.

ε_s = strain in tensile reinforcement at failure.

ε_y = strain in tensile reinforcement at yield point or proof stress.

α = ratio of resultant concrete compression C to $f_c'n'bd$, that is to the compressive force resulting from a rectangular distribution of f_c' over a depth $n'd$.

k = factor determining the distance of the resultant of the compressive stresses in the concrete from the face.

$q = \frac{pt_s}{f_c'}$. Substituting y for t_s, $q_y = \frac{py}{f_c'}$. This is called the " tensile reinforcement index."

M_u = ultimate bending moment.

$Q_u = \frac{M_u}{bd^2}$. $R' = \frac{M_u}{bd^2 f_c'}$. $R = \frac{M_u}{bd^2 u}$. The index b added to p, q, etc., indicates a " balanced " design, but for the sake of simplicity $Q_{ub} = Q_b$ and $M_{ub} = M_b$.

This notation is based partly on American practice because the most up-to-date information on the force developed by the compression zone of the concrete and its position is contained in an American publication, and the coefficients α and k are related to the cylinder strength.[13]

The strength (*Table* 3) obtained with standard American cylinders (12 in. high by 6 in. diameter) is slightly (6 to 8 per cent.) higher than the strength obtained with prisms with a ratio of height to width of 3 : 1 ; further increase of this ratio has little influence on the crushing strength of the prism.[14] The ratio of prism strength to cube strength varies, and any fixed relation between them is a rough

approximation only. According to Professor Roš[14] a ratio of 0·8 is a reasonable average for concrete with a cube strength not exceeding 5000 lb. per square inch; for concrete of over 5700 lb. per square inch a ratio of 0·70 is suggested.

Almost simultaneously with the U.S. paper[13] the results of research on the same subject carried out in Germany were also published.[15] The average of the ratio of prism strength to cube strength was 0·88, with separate values varying between 0·74 and 1·04. An average of 0·88 based on 20-cm. cubes corresponds to an average of about 0·8 for 6-in. cubes. Broadly speaking, the agreement between the coefficients given in [13] and [15] is reasonable, but it is more convenient to adopt the values in [13]. The Austrian code assumes a ratio of 0·80 (based on 20-cm. cubes), whilst the British code assumes a ratio of 0·76 (based on 6-in. cubes).

TABLE 3.

COEFFICIENTS RELATING TO THE STRENGTH OF CONCRETE CYLINDERS

f_c' lb. per sq. in.	ε_u	α	k
2000	0·0037	0·89	0·54
3000	0·0035	0·80	0·58
4000	0·0034	0·74	0·61
5000	0·0032	0·69	0·64
6000	0·0031	0·65	0·65
7000	0·0029	0·62	0·66
8000	0·0028	0·60	0·67

[The significance of the symbols which are not self-explanatory is shown in *Fig.* 1.]

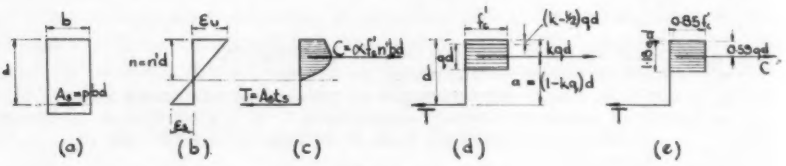


Fig. 1.

As in the standard method, in the ultimate-strength method a straight-line distribution of the strain is assumed [*Fig.* 1(b)] but, contrary to the standard method, a non-linear distribution of the stresses in the concrete is assumed [*Fig.* 1(c)].

Except in the case of beams with a comparatively low value of q_y, and reinforced with cold-worked steel which may be fractured, failure occurs when the strain in the extreme compressed face of the concrete reaches a critical value. Depending on the relative strength of the reinforcement and the concrete, characterised by the tensile reinforcement index q_y, this may happen when the strain in the steel $\varepsilon_s \gtreqless \varepsilon_y$ that is when the stress in the steel $f_s \gtreqless y$. If $f_s \geq y$ the section is called under-reinforced, if $f_s < y$ it is called over-reinforced. The boundary between the two is the so-called " balanced " design. This contains the maximum percentage of steel at which $f_s = y$.

The percentage of reinforcement for a balanced design cannot easily be determined by experiment. Indeed it is often difficult to see from a test whether y has been reached at failure. In view of the inevitable variations of the strength

of the concrete, and also of y, which are not known in advance, p_b may be defined as the percentage of reinforcement at which the chance of $t_s = y$ and $t_s < y$ is equal.

Apart from the case when the reinforcement is fractured, the apparent cause of failure is always the crushing of the concrete in the compression zone. This has often caused misunderstanding of the real cause of failure, and many failures due to tension or bond-slip have been called compression failures. The real cause of failure when $t_s \geq y$ is the excessive elongation of the reinforcement, which causes a rise of the neutral axis until the depth of the compression zone is so reduced that the concrete is crushed. Bond-slip has the same effect. The nearer the percentage of the reinforcement approaches the percentage producing a balanced design, the more difficult it is to decide whether failure is in tension or in compression. The real criterion is whether the load-bearing capacity can be significantly increased by increasing the amount of tensile reinforcement or by increasing the strength of the concrete, other conditions remaining equal. It is only by careful analysis of the results of tests that over-reinforced and under-reinforced beams near a balanced design can be distinguished. When the effect of increased strength of the steel on the load-bearing capacity is investigated the question of balanced design has to be considered first, although from the practical point of view it is less significant, as will be shown later.

The basic equation for the bending moment at failure in bending only of an under-reinforced retangular section with tensile reinforcement only, as may easily be obtained from *Fig.* 1(d), is

$$M_u = \frac{pt_s}{f_c'}\left(1 - k\frac{pt_s}{f_c'}\right)bd^2f_c' \quad . \quad . \quad . \quad . \quad (1)$$

or

$$M_u = q(1 - kq)bd^2f_c' \quad . \quad . \quad . \quad . \quad . \quad (1a)$$

Hence

$$R' = q(1 - kq) \quad . \quad . \quad . \quad . \quad . \quad . \quad (1b)$$

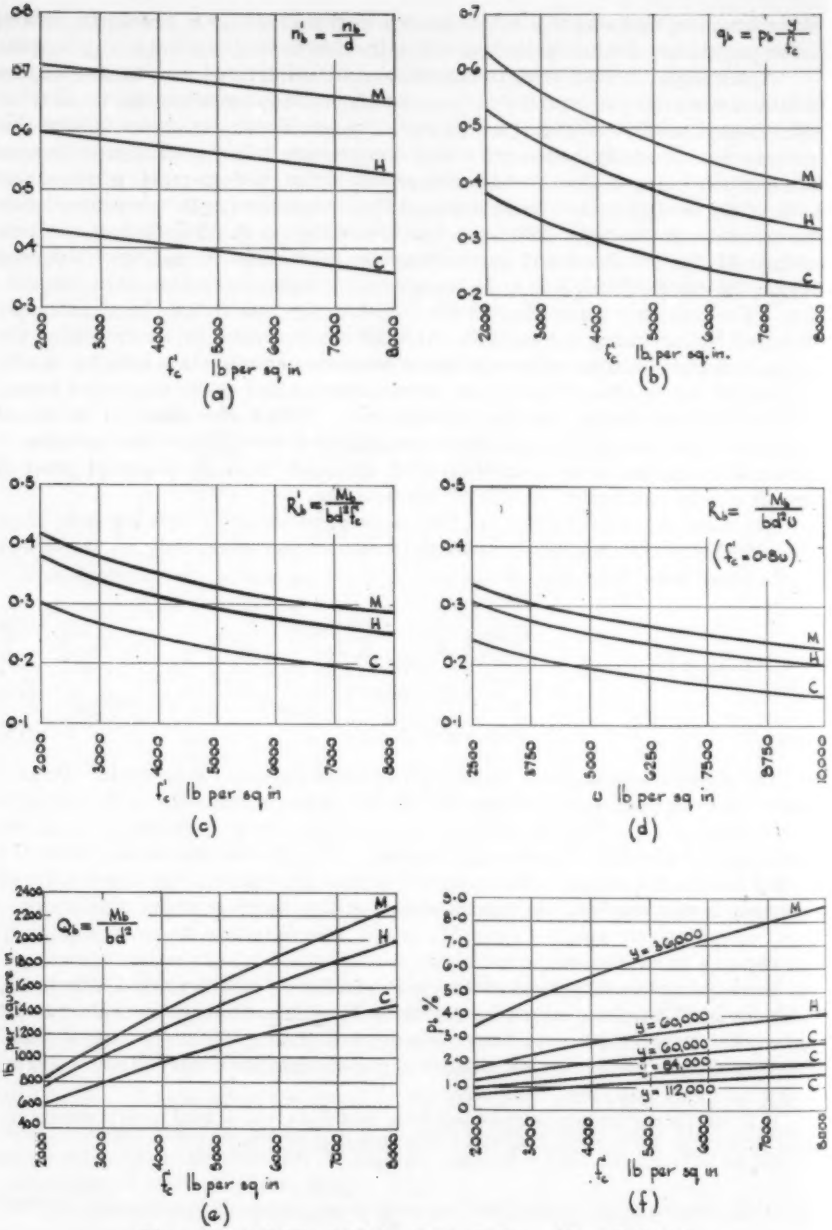
The physical meaning of terms in this equation requires explanation. At first glance it may appear from equation (1) that M_u depends primarily on the strength of the concrete f_c'. This, however, is not the case, since f_c' occurs as a divisor before and as a multiplier after the bracket. Only the second term within the bracket is affected by f_c'. The influence of this second term increases with an increasing tensile reinforcement index and is, within the range of practical applications, comparatively small. Thus M_u is not very sensitive to variations of f_c' and depends primarily on pt_s.

Equation (1) is in general form, and contains an undetermined value of t_s which for small values of q may be substantially greater than y, or, in the case of cold worked steel, may be equal to or even greater than t_u. For practical applications t_s is assumed to be y, which allows a greater margin of safety than is aimed at if q is small (say, less than 0·2).

If R' and k are known or assumed from test data, the actual tensile reinforcement index can be obtained by resolving equation (1*b*) for q:

$$q = \frac{1 - \sqrt{1 - 4kR'}}{2k} \quad . \quad . \quad . \quad . \quad (1c)$$

Hence the lever-arm at failure $a = (1 - kq)d \quad . \quad . \quad . \quad . \quad . \quad (1d)$



M = mild steel, H = high-tensile steel, C = cold worked steel.

Fig. 2.

The depth of a rectangular stress-block of intensity f_c' is qd [*Fig.* 1(d)], which is substituted for the actual stress-block [*Fig.* 1(c)] of irregular shape. It should be noted that the distance of the centre-line of the rectangular stress-block from the top is kqd, that is a small strip of concrete of depth $(k - \frac{1}{2})qd$ is excluded at the top of the section. The factor k varies with the quality of concrete (*Table* 3). The use of a rectangular stress-block is only a mathematical device to approximate the effect of the true stress distribution, which varies with the quality of the concrete. Various assumptions regarding the shape of the stress-block (second to fifth degree parabola, hyperbola, ellipse, rectangle combined with a triangle intersecting the neutral axis, etc.) make the calculation more complicated without improving its accuracy.

In a further simplification proposed by Mr. Charles S. Whitney a rectangular stress-block of intensity $0{\cdot}85\,f_c'$ is assumed irrespective of the quality of the concrete. This results in a depth of stress-block of $1{\cdot}176qd$ and $k = 0{\cdot}59$ = constant [*Fig.* 1(e)]. According to *Table* 3, k increases from 0·54 to 0·67 if f_c' increases from 2000 to 8000 lb. per square inch. Mr. Whitney's simplification, which ignores this variation of k, is a very good approximation. The actual depth of the neutral axis $n'd$ is always greater than the depth of the assumed rectangular stress-block.

Balanced Design for Various Qualities of Steel and Concrete.

For a balanced design $\varepsilon_s = \varepsilon_y$, $f_s = y$

$$n_b' = \frac{\varepsilon_u + \varepsilon_y}{\varepsilon_u} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$C = \alpha f_c' n_b' bd = T = A_s y \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Hence

$$p_b = \alpha n_b' \frac{f_c'}{y} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$q_b = p_b \frac{y}{f_c'} = \alpha n_b' \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

$$Q_b = \frac{M_b}{bd^2} = q_b(1 - kq_b)f_c' \quad . \quad . \quad . \quad . \quad . \quad (6)$$

$$R'_b = \frac{M_b}{bd^2 f_c'} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

With these equations and *Table* 3 the values for a balanced design can be determined for the whole practical range of concrete strength and for any given or assumed quality of steel. This has been done for the following qualities of steel:

	y lb. per sq. in.	ε_y
(1) Mild steel (M)	36,000	0·0015
(2) High-tensile (hot rolled) (H) . .	60,000	0·0025
(3) Cold worked (C)	50,000 to 112,000	0·0050

Since the limit of proportionality is lower than the yield point, slightly higher values for ε_y have been assumed for both (1) and (2) than $\frac{y}{30{,}000{,}000}$ (0·0012 and

0·002 respectively). For cold worked steel $\varepsilon_y = 0{\cdot}005$ is determined by arbitrary definition, whilst y may vary from 50,000 to about 112,000 lb. per square inch according to the quality of steel and the method of cold working. (For steels now available abroad with a proof stress of about 112,000 lb. per square inch ε_y is generally slightly higher than 0·005 since y is based on a permanent strain of 0·002. This difference is ignored for the sake of simplification). The results are plotted in *Fig.* 2.

The depth of the neutral axis (n_b') decreases slightly with increasing strength of concrete, but the reduction of q_b and R_b' is more rapid. On the other hand, an increase of y (characterised by an increase of ε_y) causes a much greater reduction of all quantities. The values of Q_b show that by increasing f_c' four times Q_b is increased only 2·76 times for mild steel, 2·64 for high-tensile steel, and 2·45 times for cold worked steel. The values of Q_b for high-tensile steel are only 0·92 to 0·87 times those for mild steel, and for cold-worked steel only 0·72 to 0·64 times those for mild steel.

It was necessary to reproduce these results since the linear strain distribution is generally accepted and the Austrian code, which is the most advanced regarding the upper limit of steel stresses, is based on similar considerations, although the numerical values for ε_y, etc., are different.[16] However, the values in *Fig.* 2 do not give a true comparison and do not do justice to cold worked steel with good bond for the following reason.

The straight-line relationship between ε_u and ε_y [*Fig.* 1(b)] does not take into account the variation of the stress in the steel in the longitudinal direction of the reinforcement which occurs if bond between cracks is maintained until failure. With yielding steel, or with cold worked steel without good bond, this assumption is correct, since during the process of yielding the cross-section of a bar is reduced and the bond may be destroyed within the whole range of maximum bending moment before the range on the stress-strain diagram can be reached where the stress begins to rise again with increasing strain. With cold worked bars, on the other hand, the stress increases continuously with increasing strain beyond the proof stress, and in the case of deformed bars or rusted wires the bond between cracks can be maintained until failure. Consequently the stress in the steel varies between the cracks. It reaches a maximum within cracks and a minimum between two cracks. *Fig.* 1(b) applies to the average steel strain but not to the maximum, which occurs only in very short lengths at the cracks. It follows from this variation of steel strain that the depth of the neutral axis must also vary, being the minimum at cracks and greater in uncracked portions. The concrete can carry greater forces on the reduced depth of the neutral axis than can be expected from f_c', since the higher stresses are confined to a very short range and are reduced on both sides of the cracks owing to the increased depth of the neutral axis (*Fig.* 3[17]).

Tests on beams with cold worked steel at or near the percentage for a balanced design are rare, but the results available indicate that with well-bonded reinforcement the values for a balanced design are higher than is shown in *Fig.* 2. This means that so far as cold worked deformed* bars are concerned, the ultimate-load method of design, ignoring the variations of the depth of the neutral axis as

* The term "deformed" bar is used here in accordance with the American Standard A305–53T and not in accordance with the definition in the British Code of Practice.

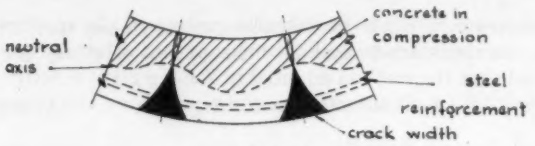


Fig. 3.

outlined here, errs on the safe side in a similar way as does the standard method. This is demonstrated in *Table* 4.

Table 4 contains the analysis of thirteen beams which were either nearly "balanced" or over-reinforced. The data for the first seven beams are partly abstracted from a paper by Professor A. L. L. Baker,[18] and partly from a thesis by Mr. J. de Gray.[19] The results of the following four tests have been published by the writer.[20] Beam No. 23 H was part of a series of tests the first two of which have been published.[21] The data for the last beam are abstracted from a thesis by Mr. S. Revesz.[22]

The first ten lines of the table are self-explanatory. The values in line 11 have been determined by trial and error in the following way: to an assumed value of f_c' (line 11) a corresponding value of q (line 22) is obtained. This is related to the measured depth of the neutral axis (line 23). The ratio (line 24) should agree with the α-value obtained from *Table* 3 for the assumed value of f_c'. If the ratio is higher than α from *Table* 3, the assumed value of f_c' is too low, and vice versa. By making two arbitrary assumptions it is easy to find the value of f_c' which satisfies the condition $\frac{q}{n'_{test}} = \alpha$. It is well known that cube, prism, or cylinder tests do not give a correct measure of the real strength of the concrete

TABLE 4.

ANALYSIS OF VARIOUS BEAMS WHICH WERE NEARLY BALANCED OR OVER-REINFORCED

			GRAY							HAJNAL-KÖNYI				REVESZ	
1 Series															
2 Beam mark			1	2	5	6	7	9	10	E1	E2	F1	F2	23 H	E
3 Width	b	in.	3							8·5				9	2·99
4 Effective depth	d	in.	9·71	9·9	9·05	9·00	9·31	9·38	9·42	9·25	9·25	9·40	9·40	16·5	5·00
5 Reinforcement			2 Tentor	0·71 in.	2 M.S.	¾ in.	2 M.S.	½ in.	5 mm H.T.	4 M.T.	1 in.	4 Tentor	0·71 in.	H.T. wire	Rg.
6 Steel area	A_s	sq.in.	0·60	0·90	1·76	1·76	1·57	1·57	0·245	3·16	3·16	1·624	1·624	0·908	0·1046
7 Percentage $100A_s/bd$ =	p	%	1·857	1·797	4·86	4·40	3·77	3·73	0·577	4·03	4·03	2·035	2·035	0·496	0·784
8 Critical strain	ε_y		0·005	0·005	0·0015	0·0015	0·0015	0·0016	0·0008	0·0018	0·0018	0·005	0·005	0·012	0·012
9 Steel stress at ε_y	y	lb. per sq.in.	18 000	18 000	39 000	39 000	42 000	42 000	240 000	47 000	47 000	78 000	78 000	250 000	285 000
10 Cube strength	u	lb. per sq.in.	3315	4960	2360	4670	2900	4610	3890	3010	3080	3190	3170	7300	7680
11 Cylinder strength	f'_c	lb. per sq.in.	2500	4950	2080	3900	2140	3750	3300	2270	2600	2700	2520	6900	7000
12 f'_c/u			0·78	1·00	0·90	0·84	0·74	0·81	0·86	0·75	0·86	0·85	0·80	0·94	0·91
13 $q_y = py/f'_c$			0·550	0·298	0·848	0·440	0·760	0·430	0·420	0·822	0·730	0·589	0·829	0·1783	0·288
14 q_b			0·549	0·378	0·638	0·573	0·630	0·572	0·237	0·891	0·895	0·849	0·859	0·1305	0·1803
15 q_y/q_b			1·57	1·08	1·34	0·86	1·19	0·84	1·77	1·41	1·35	1·70	1·79	1·49	2·45
16 $Q_b = M_b/bd^2$		lb. per sq.in.	725	1078	643	1389	878	1329	673	857	1016	704	670	769	778
17 $R'_b = Q_b/f'_c$			0·279	0·338	0·417	0·356	0·410	0·354	0·204	0·365	0·391	0·268	0·268	0·111	0·111
18 M_{test}		1000 lb.in.	342	482	278	419	311	418	276	610	660	420	435	2095	115
19 $Q_{test} = M_{test}/bd^2$		lb. per sq.in.	900	1185	996	1806	900	1218	774	943	1020	993	947	1116	1295
20 $R'_{test} = Q_{test}/f'_c$			0·348	0·240	0·429	0·335	0·420	0·325	0·235	0·415	0·392	0·366	0·376	0·162	0·259
21 k			0·665	0·835	0·34	0·21	0·543	0·60	0·59	0·85	0·585	0·585	0·56	0·66	0·66
22 $q = (1-\sqrt{1-4kR'})/2k$			0·472	0·235	0·874	0·469	0·654	0·442	0·232	0·641	0·585	0·512	0·540	0·194	0·279
23 n'_{test}			0·96	0·42	0·76	0·63	0·76	0·59	0·30	0·740	0·709	0·620	0·643	0·195	0·45
24 $\alpha = q/n'_{test}$			0·84	0·70	0·89	0·74	0·89	0·75	0·79	0·87	0·84	0·83	0·84	0·82	0·62
25 $1-kq$			0·735	0·912	0·654	0·744	0·646	0·735	0·654	0·647	0·670	0·711	0·698	0·868	0·912
26 Lever arm $(1-kq)d$ =	a	in.	6·38	7·22	5·10	5·71	5·35	6·09	7·02	5·34	5·52	5·96	5·86	13·50	4·08
27 Steel stress at failure	f_s	lb per sq.in.	67 000	80 000	51 000	41 500	37000	45 500	161 800	36 200	37 900	69 200	66 800	235 000	270 000
28 f_s/y			0·96	1·08	0·90	1·07	0·99	1·04	0·67	0·77	0·80	0·88	0·86	1·02	0·95

in a beam, however much care be taken in casting of the specimens. In earlier publications it was necessary to make a more or less arbitrary assumption for f_c' and it is believed that the method adopted in *Table* 4 gives a better approximation to the true strength of the concrete and consequently of the stress in the steel at failure. As may be seen from line 12 the ratio $\frac{f_c'}{u}$ varies between 0·74 and 1·00 which is a very reasonable range within the limits observed in [15]. A further improvement on previous work is the variation of the position of the resultant of the compressive stresses according to the quality of the concrete, as expressed by the coefficient k in line 21. This method of analysis, is, of course, applicable only if all relevant data are available, particularly if the position of the neutral axis has been carefully observed until near failure.

Line 13 contains the tensile reinforcement index, line 14 the theoretical value of this index for balanced design, and line 15 their ratio. If this ratio is greater than 1 the beam appears to be over-reinforced; if it is less than 1 the beam appears to be under-reinforced. All beams in the table were apparently over-reinforced except Nos. 6 and 8 in Mr. Gray's series, the apparent degree of over-reinforcement varying between 1·06 and 2·43. The important comparison is that of lines 15 and 28, that is of the degree of over-reinforcement and the ratio of the stress in the steel at failure to the critical steel stress.

Theoretically, for balanced design both values should be 1. For $\frac{q_w}{q_b} < 1$, $\frac{t_s}{y} \geq 1$; for $\frac{q_w}{q_b} > 1$, $\frac{t_s}{y} < 1$. Mr. Gray's beams 6 and 8 were under-reinforced, and $\frac{t_s}{y} > 1$. On the other hand his beam No. 2 (reinforced with Tentor bars) and the writer's beam No. 23 H (reinforced with high-tensile wires) appear to be over-reinforced $\left(\frac{q_w}{q_b} = 1{\cdot}06 \text{ and } 1{\cdot}49 \text{ respectively}\right)$ yet $\frac{t_s}{y}$ slightly exceeds unity in both cases. In Mr. Revesz's beam E (reinforced with high-tensile wires) $\frac{t_s}{y}$ is still 0·95, although $\frac{q_w}{q_b} = 2{\cdot}45$. Admittedly this beam contained two wires (one-sixth of the tensile reinforcement) in the compression zone, but these wires could have hardly developed a stress higher than 60,000 lb. per square inch and could not have balanced more than 4 per cent. of the tensile reinforcement.

Among the beams with Tentor reinforcement, Mr. Gray's beam No. 1 and the writer's beams F1 and F2 were definitely over-reinforced, but in spite of the apparently high degree of over-reinforcement (1·57 to 1·79), the ratio $\frac{t_s}{y}$ is relatively high, that is 0·86 to 0·88. In beams with mild steel (Mr. Gray's beams Nos. 5 and 7) and medium-tensile steel reinforcement (the writer's beams E1 and E2) a much lower degree of over-reinforcement (between 1·19 and 1·41) has reduced the ratio $\frac{t_s}{y}$ to 0·77 to 0·88. All these figures indicate that for cold

worked bars with good bond the values for balanced design are higher than those obtained from *Fig.* 2, whereas for bars with poor bond they are correct.

Mr. Gray's beam No. 10 requires some explanation. With $\frac{q_y}{q_b} = 1{\cdot}41$ and $\frac{'_s}{y} = 0{\cdot}67$ it is in great contrast to the two other beams with high-tensile wires included in *Table* 4. The reason is the difference in bond, which was very poor in the case of the smooth wires used in beam No. 10, as is proved by the small number of cracks in comparison with all the other beams of the same series. The wires in Mr. Revesz's beam E were exposed to rain for a long time, whereas those in beam 23H were artificially corroded. The better performance of the rusted and corroded wires in comparison with that of Tentor bars is due to the difference in size.

Many attempts were made to correct the theoretical values by introducing a factor F for ε_y and in this way to take into account the effect of bond. All these attempts are based on average strain readings. In the writer's view this approach to the problem cannot yield satisfactory results because the maximum local strain within cracks, which is the real criterion of failure, cannot be determined from average readings even if the gauge length is only 2 in. Professor R. H. Evans has proved[23] that the strain measured at the crack on a gauge-length of 1 in. is considerably greater than the strain measured on a gauge-length of 8 in. There is every reason to expect that it would be still greater if measured on a gauge-length of say, $\frac{1}{4}$ in. or even less. In a recent publication[24] he concluded that the ratio of the maximum strain in the reinforcement to the average strain in the surface of the concrete at the level of the reinforcement for $\frac{5}{16}$-in. twisted square bars and two-point loading reaches 1·5. Until a method is invented to measure local strains within cracks the only way to establish the limiting values for a balanced design with well-bonded cold worked reinforcement seems to be to make more tests with various qualities of concrete and to draw conclusions not from strain readings at the surface but from the values of Q and R_b on a statistical basis.

In this connection two beams tested by Mr. J. J. Janney may also be mentioned.[25] Both were reinforced with untensioned wires of 0·197 in. diameter with an ultimate tensile strength of 250,000 lb. per square inch. The strength of the concrete tested as cylinders was 4500 lb. per square inch ($q = 0{\cdot}085$). In one beam the wires were clean, in the other they were rusted. The beam with the clean wires cracked at a load of 2700 lb. and failed at 2950 lb. by bond-slip. The beam with the rusted wires cracked at a load of 2750 lb. and failed at 10,100 lb. by fracture of the wires.

The condition of exceeding the values of Q_b for cold worked steel given in *Fig.* 2 is excellent bond. The importance of good bond when high-tensile steel is used cannot be over-emphasised. For this reason high-tensile bars should be deformed. This applies equally to bars with a natural yield-point and to cold worked bars. If smooth wires are anchored intermittently by other means, for example in welded fabrics or "Bi"-steel, the bond is still destroyed between cracks.

Fig. 2 also gives the percentages of reinforcements for a "balanced" design. These are theoretical values only since in practical design a fair margin has to be

allowed, and compression steel has to be added at a percentage below p_b for reasons of safety and serviceability.

So long as q does not exceed q_b the load-bearing capacity of a beam in a given quality of concrete depends only on q as expressed by equation (1b).

Denoting by A_s and y the sectional area of high-tensile steel and its yield-point or proof stress respectively, and by A_s' and y' the corresponding values for mild steel, the equation $A_s y = A_s' y'$ expresses the equivalence of high-tensile and mild steel for $q < q_b$ from the point of view of load-bearing capacity even if y is as high as 285,000 lb. per square inch. Steel of such quality cannot, of course, be used economically in un-prestressed concrete because of excessive deformation and cracking. Its unsuitability for ordinary reinforced concrete is determined by the requirements of serviceability and has nothing to do with safety.

Two important conclusions may be drawn from *Fig.* 2.

(1) The values of p_b for mild steel in high-strength concrete (say, $f_c' > 4000$ lb. per square inch) are so high that even with a fair margin against them it is not practical to provide the quantity of mild steel required for the utilisation of the high strength of the concrete. *The economical use of high-strength concrete necessitates the use of high-tensile steel.*

(2) The new British Code introduces the following limiting values of Q at working loads:

Nominal mixture	$Q_{permissible}$ lb. per sq. in	$2Q_{permissible} = Q_u$ lb. per sq. in.	Assumed f_c' lb. per sq. in.
1 : 2 : 4	250	500	2000
1 : 1½ : 3	312·5	625	2500
1 : 1 : 2	375	750	3000

These values of $2Q_{perm.} = Q_u$ are well below the values of Q_b corresponding to the assumed values of f_c', even for cold worked steel. Since the values for cold worked steel in *Fig.* 2 are conservative in the case of deformed bars, and the assumption that $f_c' = \frac{2}{3}u$ is also conservative, the sections are under-reinforced with ample margin against a balanced design.

The ultimate-load method as introduced in the new British Code has eliminated the handicap under which the use of high-tensile steel has suffered on the basis of the standard method, and the relation $A_s y = A_s' y'$ can be applied with confidence.

It is hoped to discuss further the practical limitations of p and q in a later article.

(To be continued.)

REFERENCES.

(12) Charles S. Whitney and Edward Cohen. Guide for Ultimate Strength Design. "Journal of the American Concrete Institute", November 1956, p. 455.

(13) Eivind Hognestad, N. W. Hanson and Douglas McHenry. Concrete Stress Distribution in Ultimate Strength Design. "Journal of the American Concrete Institute", December 1955, p. 455.

(14) M. Roš. Die materialtechnischen Grundlagen und Probleme des Eisenbetons im Hinblick auf die zukünftige Gestaltung der Stahlbeton-Bauweise. Eidgenössische Materialprüfung-und Versuchsanstalt Bericht, Nr. 162. Zürich, 1950.

(15) H. Rüsch. Versuche zur Festigkeit der Biegedruckzone. Deutscher Ausschuss für Stahlbeton, Heft 120, Wilhelm Ernst & Sohn. Berlin, 1955.

(16) Karl Jäger. Die Bemessung der Stahlbetonbauteile nach Önorm B4200, 4. Teil unter besonderer Berücksichtigung des Traglastverfahrens. Manzsche Verlags-und Universitätsbuchhandlung, Wien. 1952.

(17) S. Revesz. Contribution to a discussion. "Magazine of Concrete Research", Vol. 8, No. 23, 1956, p. 118.
(18) A. L. L. Baker. Recent Research at Imperial College on the Design of Reinforced Concrete Framework by Ultimate Load Theory. "Reinforced Concrete Review", Vol. III, No. 6, 1954, p. 313.
(19) J. de C. Gray. Influence of Bond on Neutral Axis Position and Crack Spacing in Reinforced Concrete. Thesis submitted for M.Sc. degree in the Faculty of Engineering in the University of London, 1953.
(20) K. Hajnal-Kónyi. Recent Research on Deformed Reinforcement Bars. "Reinforced Concrete Review", Vol. III, No. 7, 1955.
(21) K. Hajnal-Kónyi. Tests on concrete beams reinforced with 12-gauge wires of an ultimate strength of 120 tons per square inch. "Magazine of Concrete Research", No. 9, March 1952, and No. 12, April 1953.
(22) Stephen Revesz. The Behaviour of Prestressed Concrete Beams. Thesis submitted for the M.Sc. degree in the Faculty of Engineering of the University of London, 1951.
(23) R. H. Evans. The Plastic Theories for the Ultimate Strength of Reinforced Concrete Beams. "Journal of the Institution of Civil Engineers", December 1943, p. 98.
(24) R. H. Evans and A. Williams. Bond Stress and Crack Width in Beams Reinforced with Square Grip Reinforcement. RILEM Symposium on Bond and Crack Formation in Reinforced Concrete, Stockholm, 1957. Vol. I, p. 105.
(25) Jack J. Janney. Nature of Bond in Pre-Tensioned Prestressed Concrete. "Journal of the American Concrete Institute", May 1954, p. 717.

Footbridge in Eire.

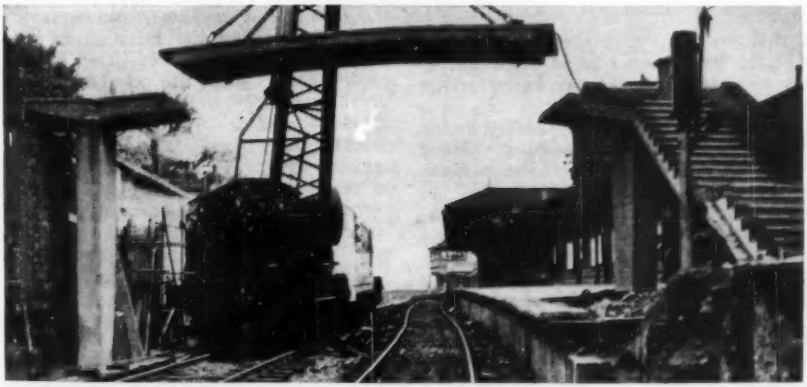


Fig. 1.

A FOOTBRIDGE with a clear span of 31 ft. has been erected at Dun Laoghaire railway station for the Irish State Railways. The central 22 ft. of the main span was precast as one piece weighing 8 tons and placed on bearings on two slabs, each 4 ft. 6 in. long, cantilevered from the main piers (Fig. 1). One of these slabs was cast in place; the other was precast, hinged at the supporting pier, and anchored by a plain concrete retaining wall behind the pier. The restraint for the slab cast in place is provided partly by approach stairs and partly by an eccentric footing to the pier.

The erection of the shuttering inside the profile of the railway loading-gauge was not permitted, and the construction depth was limited by the profile of the loading-gauge and the level of an existing footpath giving access to the bridge. Mr. D. Herlihy is the chief engineer of the Irish State Railways. The reinforced concrete design was prepared by the British Reinforced Concrete Engineering Co., Ltd.

Book Reviews.

"Explanatory Handbook on the B.S. Code of Practice for Reinforced Concrete (No. 114, 1957)." By W. L. Scott, W. H. Glanville, and F. G. Thomas. (London: Concrete Publications, Ltd. Price 12*s.* 6*d.*; by post 13*s.* 6*d.* 3 dollars in Canada and U.S.A.)

THE new edition of the Handbook retains the general arrangement of the previous editions. The authors give a clear and authoritative interpretation of the recommendations of the Code, the full text of which is included, and many additional tables and diagrams are given. A feature of the book is the inclusion of design tables and data relating to the load-factor method, in addition to those for use with the elastic theory.

"Reinforced Concrete Designer's Handbook." By Chas. E. Reynolds. Fifth Edition. (London: Concrete Publications, Ltd. Price 18*s.*; by post 19*s.* 5*d.* 4 dollars in Canada and U.S.A.)

IN this new edition the text, tables, and examples have been revised where necessary to incorporate the recommendations of the new Code of Practice No. 114 (1957), and full details of the load-factor method of design are included. Other improvements or additions have been made to the sections dealing with the pressures of granular and cohesive materials, foundations, slabs supported on three or four sides and subjected to triangular load, loads on bridges, long columns, and the properties of reinforced concrete sections.

"Reinforced Concrete." By J. McHardy Young. (London: Crosby Lockwood & Son, Ltd. Price 12*s.* 6*d.*)

THE third edition of this book is stated to be in accordance with the new Code of Practice No. 114 (1957), but several passages are not consistent with the recommendations of the Code.

The book presents the elementary theory and design of reinforced concrete in a highly condensed form, and much of the introductory theory is omitted. There are some curious inconsistencies. For example, in view of the omission of much of the elementary theory of bending, it seems unnecessary to define a moment of resistance; the Code does not recommend that secondary steel in slabs should be 10 per cent. of the main steel; it is certainly more than "good practice" which requires compressive bars to be restrained from buckling; and the statement that the breadth of the rib of a tee-beam is usually determined by the shearing stress needs amplification. The book appears to be insufficient to meet the needs of students, and would be of little use to experienced engineers.

"Rahmenformeln." By Professor Kleinlogel. 12th Edition, 1957. (Berlin: Wilhelm Ernst & Sohn. Price 52 D.M.)

THOSE who have used previous editions of this book may wonder how other designers of rigid frames manage without the saving in time and labour that is possible with its help. There can be very few single-span frames for which the bending moments, shearing forces, and thrusts cannot be calculated directly by the formulæ it contains, and it is also possible to apply the formulæ to some multiple-bay structures. The present edition differs from the previous one by the inclusion of eleven new frames in place of eleven which occur infrequently in practice, and there are simplifications of some of the formulæ. That this book is in the German language is of little importance to those who cannot read that language, as the mathematical expressions and diagrams are self-explanatory.—J. E. G.

Competition for the Design of a Factory

A COMPETITION for the design of a reinforced concrete factory building is announced by the Cement Marketing Co., Ltd.

The prizes are £1000, £500, and £250 for the designs placed first, second, and third respectively. The competition is open to architects, architectural students and engineers resident in the British Isles, and the designs submitted are to be the joint work of architects and engineers. The conditions of the competition are available from the Publicity Department, Cement Marketing Co., Ltd., Portland House, Tothill Street, London, S.W.1. Designs must be delivered not later than 1 April, 1958.

Design of Eccentrically-Loaded Columns by the Load-Factor Method.

2.—Symmetrical Mild Steel Reinforcement.*

By J. D. BENNETT, B.Eng.

In the previous article, on columns reinforced with cold worked bars, formulæ were developed on the basis recommended in the British Standard Code of Practice No. 114 (1957) for the design of columns by the load-factor method. For columns reinforced with mild steel the permissible stresses in the steel are $p_{sc} = 18{,}000$ lb. per square inch and $p_{st} = 20{,}000$ lb. per square inch, and Young's modulus can be assumed to be constant at 30×10^6 lb. per square inch. Using these stresses, and working in a manner similar to that described in the previous article, the following equations are obtained for columns with symmetrical reinforcement. For failure in compression:

$$\frac{P}{bdp_{cc}} = \frac{d_1}{d}X + 9000\frac{r}{p_{cc}} - 25{,}000\frac{r}{p_{cc}}.\frac{0{\cdot}85 - X}{X} \quad . \quad . \quad (8)$$

$$\frac{M}{bd^2p_{cc}} + \frac{P}{bdp_{cc}}.\frac{d_1 - d_2}{2d} = \left(\frac{d_1}{d}\right)^2.X.\left(1 - \frac{X}{2}\right) + 9000.\frac{r}{p_{cc}}.\frac{d_1 - d_2}{d} \quad . \quad (9)$$

For failure in tension: $$\frac{P}{bdp_{cc}} = \frac{d_1}{d}.X - 1000.\frac{r}{p_{cc}} \quad . \quad . \quad . \quad . \quad (10)$$

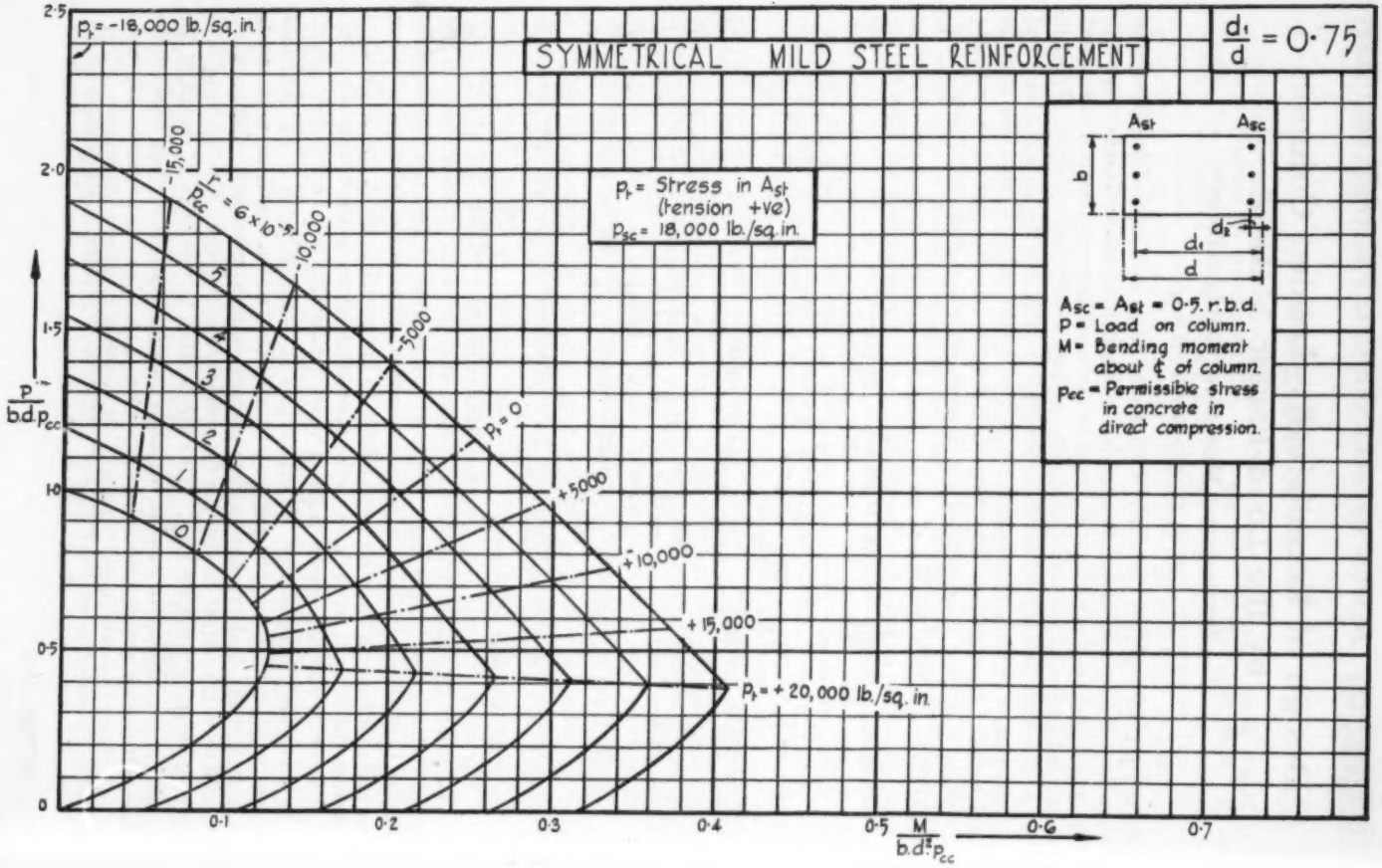
$$\frac{M}{bd^2p_{cc}} + \frac{P}{bdp_{cc}}.\frac{d_1 - d_2}{2d} = \left(\frac{d_1}{d}\right)^2.X.\left(1 - \frac{X}{2}\right) + 9000.\frac{r}{p_{cc}}.\frac{d_1 - d_2}{d} \quad . \quad (11)$$

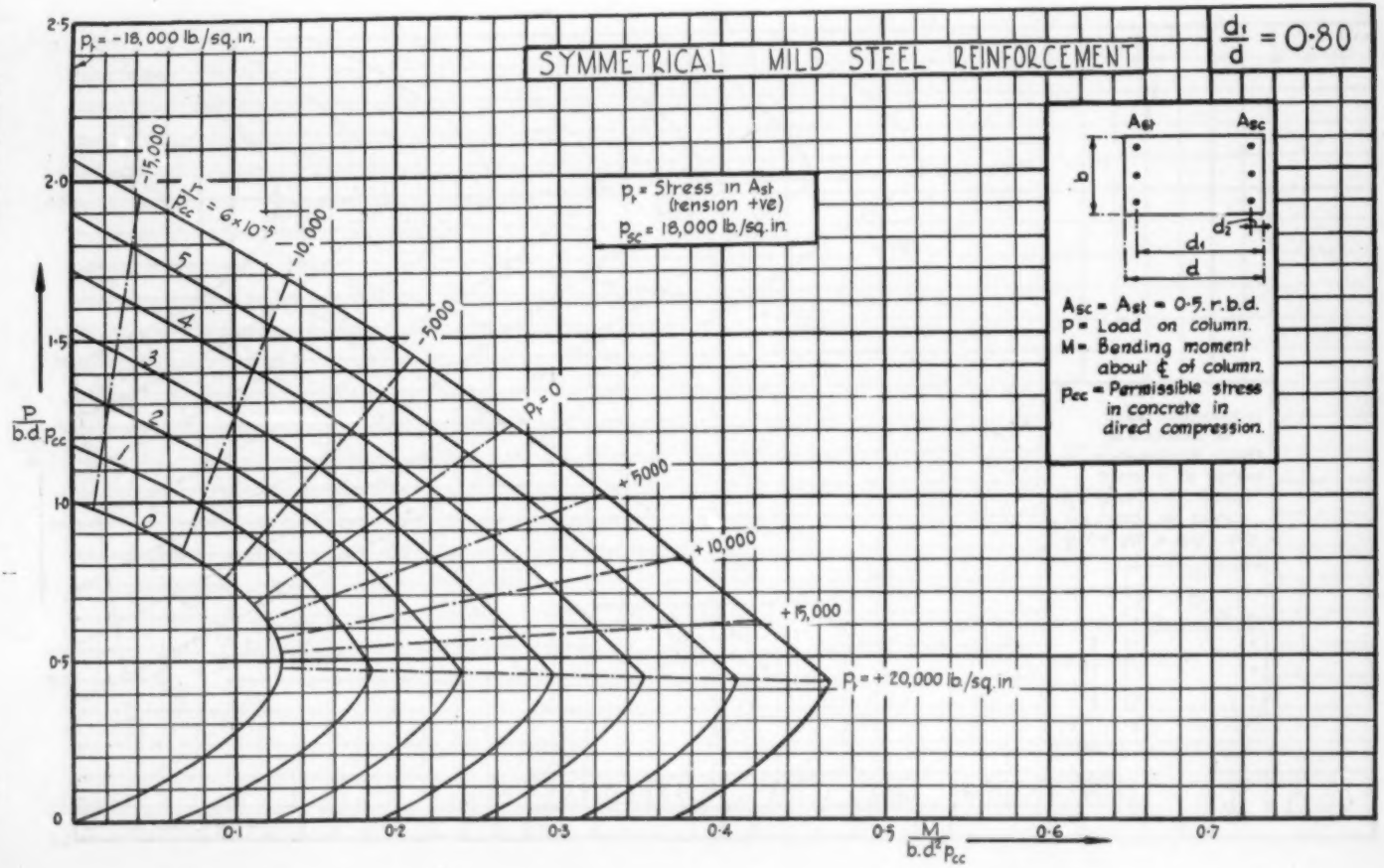
Using these equations, $\frac{P}{bdp_{cc}}$ is plotted against $\frac{M}{bd^2p_{cc}}$ for various ratios of $\frac{d_1}{d}$. These curves are used to determine $\frac{r}{p_{cc}}$ for a given bending moment, load, strength of concrete, and size of column.

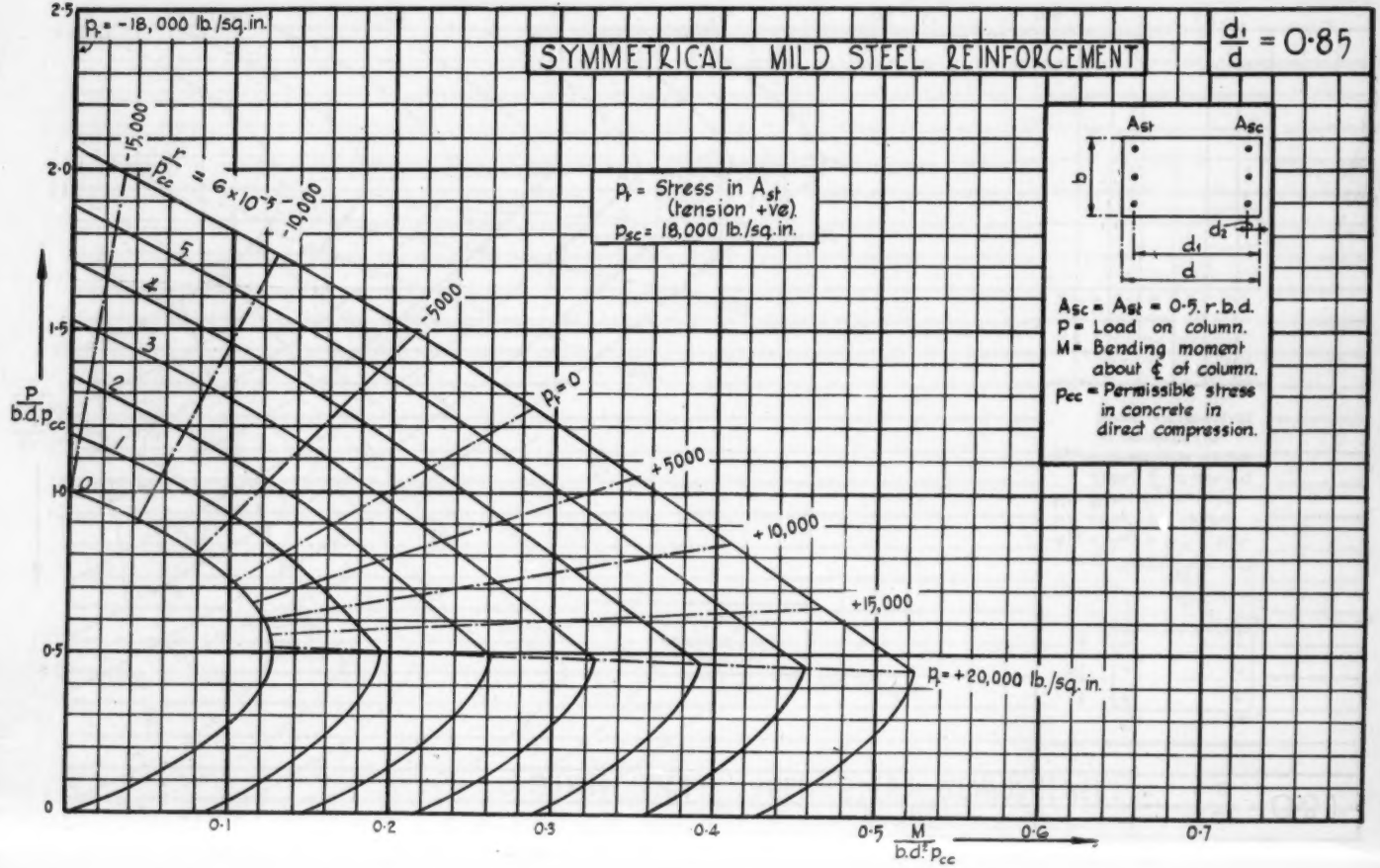
Equations (10) and (11) give the same result as equation (20) of the Code, but equations (8) and (9) for failure in compression give a curve where equation (19) of the Code gives a straight line. This curve gives areas of steel which are slightly smaller than those obtained from the recommendations of the Code. The reason for this difference is that the curve relates to the actual stress in the tensile steel whereas the straight line relates to the permissible stress in the tensile steel, and this stress is not necessarily reached when failure due to compression occurs. The curve has the additional advantage that it can be adapted to the design of eccentrically-loaded columns with unsymmetrical reinforcement, whereas equation (19) of the Code applies only to columns with symmetrical reinforcement.

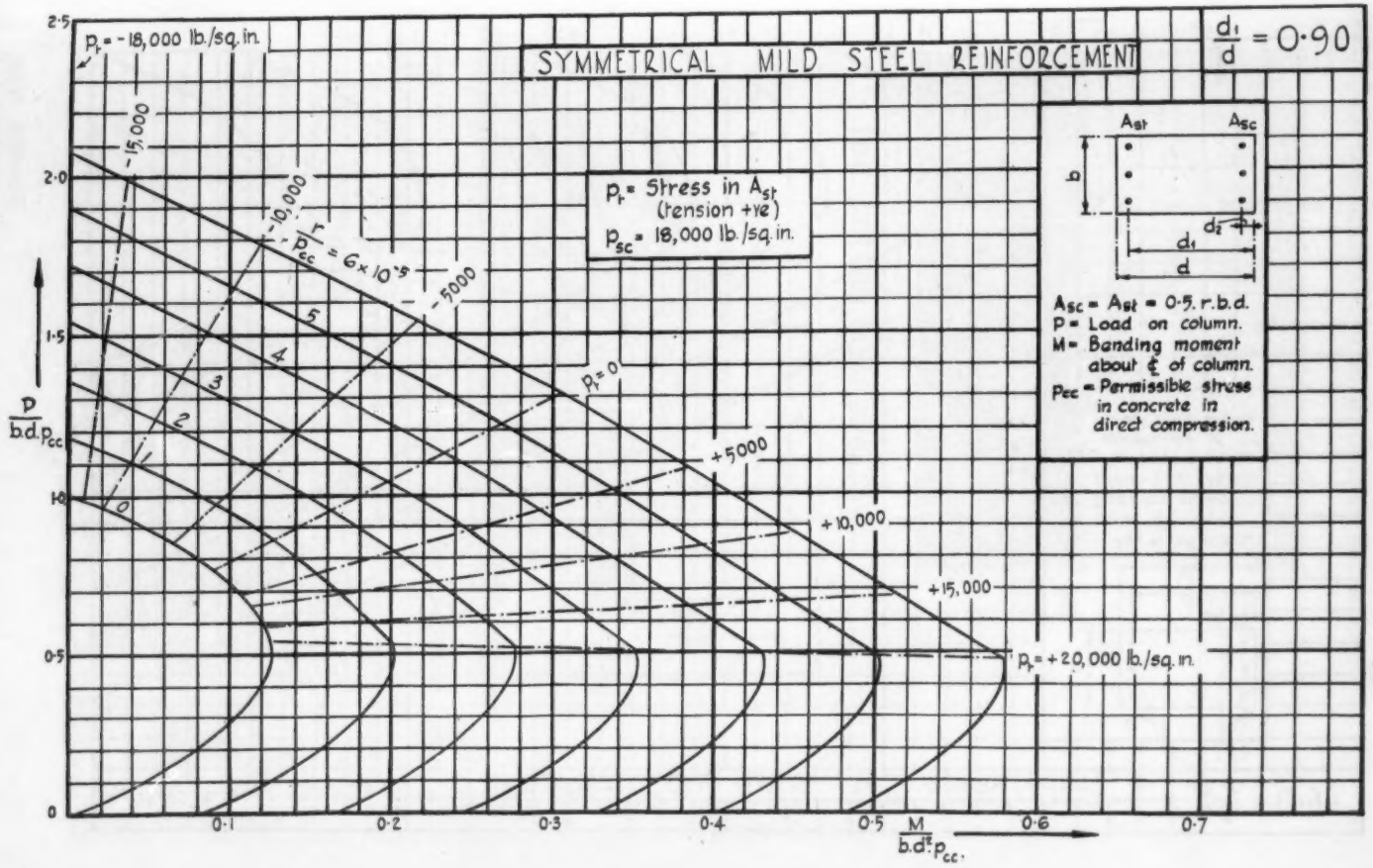
Note: The stress in the tensile reinforcement p_t shown on the graphs is half the stress at ultimate load. This also applies to the stress p_t shown on the graphs in the November number, which is only half the value of p_t used in the text and defined under "Notation".

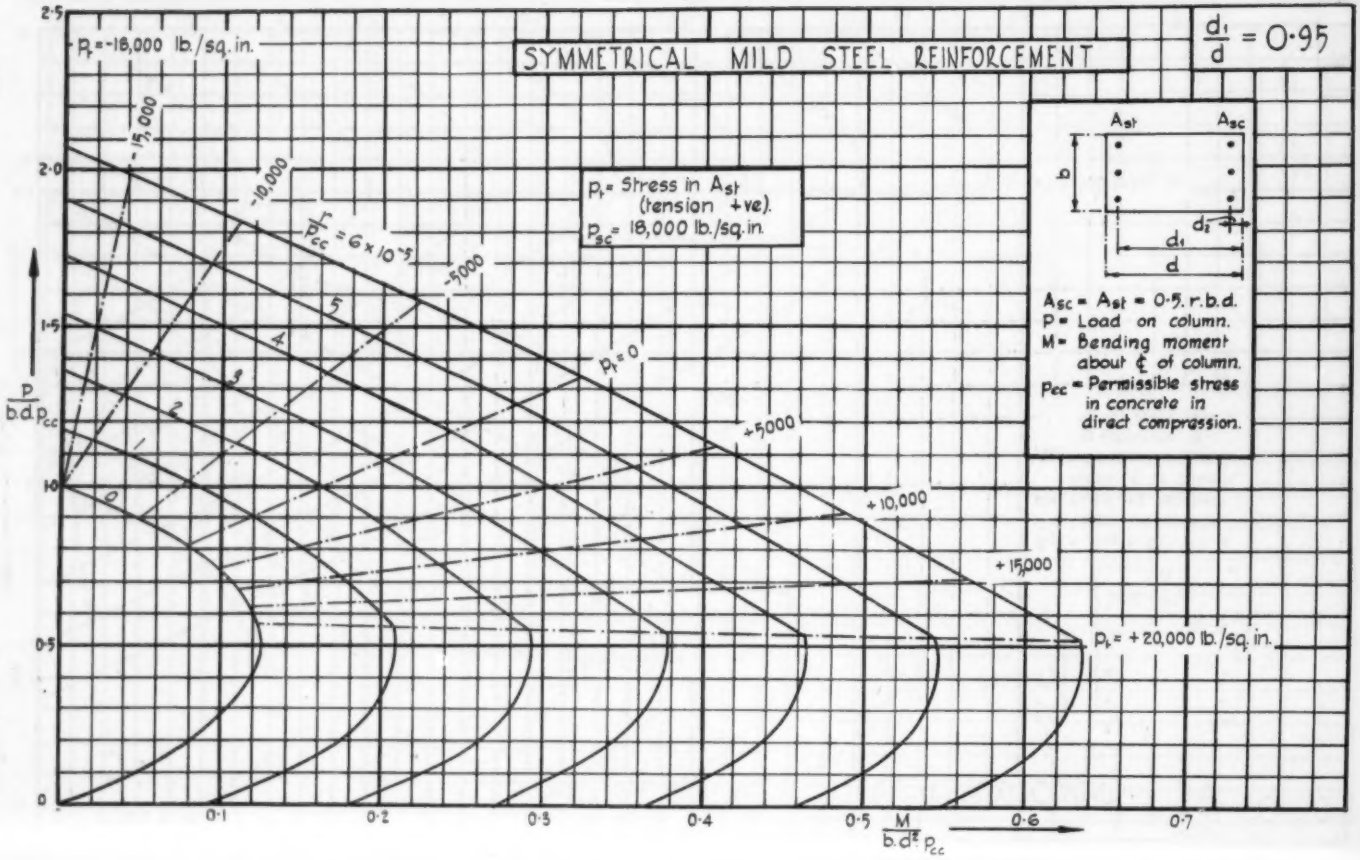
* Part 1 appears in this journal for November, 1957.


SYMMETRICAL MILD STEEL REINFORCEMENT
$\frac{d_1}{d} = 0.75$
p_t = Stress in A_{st} (tension +ve)
p_{sc} = 18,000 lb./sq. in.
A_{st}
A_{sc}
b
d_2
d_1
d
$A_{sc} = A_{st} = 0.5.r.b.d.$
P = Load on column.
M = Bending moment about ℄ of column.
p_{cc} = Permissible stress in concrete in direct compression.
p_t = -18,000 lb./sq. in.
-15,000
$\frac{p}{p_{cc}} = 6 \times 10^{-5}$
-10,000
-5000
$p_t = 0$
+5,000
+10,000
+15,000
p_t = + 20,000 lb./sq. in.
5
4
3
2
1
0
$\frac{P}{bdp_{cc}}$
2·5
2·0
1·5
1·0
0·5
0
0·1
0·2
0·3
0·4
0·5
0·6
0·7
$\frac{M}{b.d^2.p_{cc}}$


SYMMETRICAL MILD STEEL REINFORCEMENT
$\frac{d_1}{d} = 0.80$
p_t = Stress in A_{st} (tension +ve)
p_{sc} = 18,000 lb./sq.in.
A_{st}
A_{sc}
D
d_2
d_1
d
$A_{sc} = A_{st} = 0.5.r.b.d.$
P = Load on column.
M = Bending moment about ℄ of column.
p_{cc} = Permissible stress in concrete in direct compression.
p_t = -18,000 lb./sq.in.
-15,000
-10,000
-5000
$p_t = 0$
+5000
+10,000
+15,000
p_t = +20,000 lb./sq.in
$\frac{r}{p_{cc}} = 6 \times 10^{-5}$
0
1
2
3
4
5
$\frac{P}{b.d.p_{cc}}$
$\frac{M}{b.d^2.p_{cc}}$
2·5
2·0
1·5
1·0
0·5
0
0·1
0·2
0·3
0·4
0·5
0·6
0·7


SYMMETRICAL MILD STEEL REINFORCEMENT
$\frac{d_1}{d} = 0.85$
p_t = Stress in A_{st} (tension +ve).
p_{sc} = 18,000 lb./sq.in.
p_t = -18,000 lb./sq.in.
$\frac{r}{p_{cc}} = 6 \times 10^{-5}$
-15,000
-10,000
-5000
$p_t = 0$
+5000
+10,000
+15,000
p_t = +20,000 lb./sq. in.
1
2
3
4
5
$\frac{P}{b.d.p_{cc}}$
$\frac{M}{b.d^2.p_{cc}}$
0
0·5
1·0
1·5
2·0
2·5
0·1
0·2
0·3
0·4
0·5
0·6
0·7
A_{st}
A_{sc}
D
d_2
d_1
d
$A_{sc} = A_{st} = 0.5.r.b.d.$
P = Load on column.
M = Bending moment about ℄ of column.
p_{cc} = Permissible stress in concrete in direct compression.


SYMMETRICAL MILD STEEL REINFORCEMENT
$\frac{d_1}{d} = 0.90$
p_t = -18,000 lb./sq. in.
-15,000
-10,000
-5000
$\frac{r}{p_{cc}} = 6 \times 10^{-5}$
$p_t = 0$
+5000
+10,000
+15,000
p_t = +20,000 lb./sq. in.
p_t = Stress in A_{st} (tension +ve)
p_{sc} = 18,000 lb./sq. in.
A_{st}
A_{sc}
D
d_2
d_1
d
$A_{sc} = A_{st} = 0.5.r.b.d.$
P = Load on column.
M = Banding moment about ℄ of column.
p_{cc} = Permissible stress in concrete in direct compression.
$\frac{P}{b.d.p_{cc}}$
$\frac{M}{b.d^2.p_{cc}}$
0
0.5
1.0
1.5
2.0
2.5
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
1
2
3
4
5


SYMMETRICAL MILD STEEL REINFORCEMENT
$\frac{d_1}{d} = 0.95$
p_t = -18,000 lb./sq. in.
-15,000
-10,000
$\frac{p_t}{p_{cc}} = 6 \times 10^{-5}$
-5,000
$p_t = 0$
+5,000
+10,000
+15,000
p_t = +20,000 lb./sq. in.
p_t = Stress in A_{st} (tension +ve).
p_{sc} = 18,000 lb./sq. in.
A_{st}
A_{sc}
D
d_2
d_1
d
$A_{sc} = A_{st} = 0.5 . r . b . d.$
P = Load on column.
M = Bending moment about ℄ of column.
p_{cc} = Permissible stress in concrete in direct compression.
$\frac{P}{b d p_{cc}}$
$\frac{M}{b . d^2 p_{cc}}$
2·5
2·0
1·5
1·0
0·5
0
0·1
0·2
0·3
0·4
0·5
0·6
0·7
5
4
3
2
1
0

Small hand and power driven sprays available for vertical structures.

Fully Automatic machine for spraying Ritecure

for better concreting

always include

"Ritecure"

in your specification

ADVISORY SERVICE

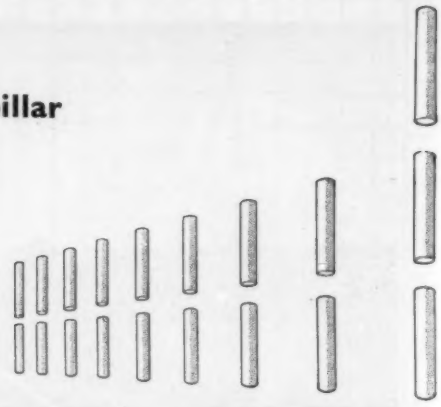
With over 35 years' practical experience our technical department can offer constructive assistance on specific concrete problems including preparation of complete specifications.

The RITECURE MEMBRANE CURING METHOD improves the quality of concrete while reducing handling costs. A single application (one gallon covers approximately 30 square yards of concrete) affords greater compressive strength with increased surface wear. Over 30 million yards of concrete in the British Isles already treated by the RITECURE method.

Write for full technical information: **STUART B. DICKENS LTD.**

36 Victoria Street, London, S.W.1. Telephone: Abbey 4930 & 6157.
Works: Manor Way, Boreham Wood, Herts. Telephone: Elstree 2211.

Think of a round pillar

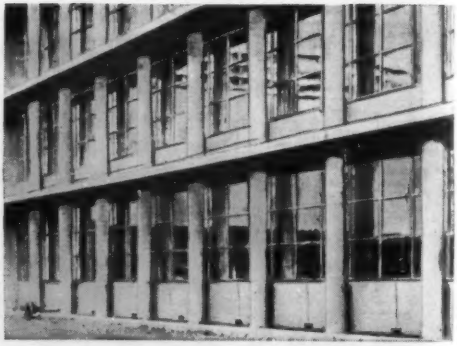


multiply it

build them with

Sonotubes

—quickly, easily and cheaply



Sonotube expendable fibre forms have been specifically developed to provide a fast and economical means of forming round columns of concrete. They save time, labour, timber and money in the construction of concrete columns, piers, piles and underpinning and are adaptable for encasing wooden piles and steel-stanchions. Steel reinforcing can be used within the tubes. Sonotube can be made an integral part of steel, cast-in-situ, or precast reinforced concrete beams. Send for detailed and fully illustrated leaflets.

Diameter: 4"ID — 36"ID. Lengths up to 25 ft. Sonotubes are easily cut on site to any desired length.

Sonotube

Expendable forms for concrete pillars

T.P.T. CONSTRUCTION PRODUCTS *division of the Textile Paper Tube Co. Ltd.*

ROMILEY, CHESHIRE, ENGLAND *Telephone:* WOOdley 2271/3/4 *Telegrams:* SONOTUBE, ROMILEY

The New Notation in B.S. Code of Practice No. 114: 1957.

MR. R. E. BOWLES, M.Sc. Tech., M.I.Struct.E., of the Manchester College of Science and Technology, writes as follows.

I am writing to you to express the views of a number of teachers and designers with extensive experience of reinforced concrete.

The new symbols contained in the revised British Standard Code of Practice for Reinforced Concrete (No. 114: 1957) are particularly objectionable because:

1. They were not included in the "Draft for Comment", and were thus not subjected to general criticism.

2. They depart from established practice which has been in use for some forty years. Whilst change for valid reasons is desirable, change for the sake of change is most objectionable.

3. Several changes are most undesirable. For example,

(a) The change of d—associated with *effective* depth in all literature for forty years—to signify *overall* depth will present the most serious difficulty to all students using existing textbooks and the new Code.

(b) Other familiar symbols such as D, p, Q, q, and R are also given new and unfamiliar meanings.

(c) Many essential symbols are not provided in the new list. There is no provision for stresses other than the maximum permissible, no symbol for the ratio or percentage of steel, and none for $n_1 = \frac{n}{d}$. The system recently established in British Standard No. 449 of using f for actual stress and F for maximum permissible stress is ignored.

4. The system of single and double suffixes is unnecessarily complicated and cumbersome, and the difficulty of writing these clearly will certainly lead to confusion. Compare also the symbol n_1 in the old system with $\frac{d_s}{d_1}$ in the new.

The use of l_a for lever-arm seems to be particularly undesirable. In all other applications l or L signifies a longitudinal measurement, and its application to the transverse lever-arm is confusing.

One has only to attempt the translation of a few of the old essential formulæ into the new symbols to see their impracticability, such as

$$n_1 = \frac{mc}{mc + t} \quad \text{and}$$

$$n_1 = rm\left\{\sqrt{1 + \frac{2}{rm}} - 1\right\}$$

5. Some changes seem fundamentally wrong. In Table 13, ratios of span to *overall* depth to limit deflection are given. Surely deflection is related to effective depth and not overall depth?

[Our opinion that the new notation used in the revised Code is unnecessary and will lead to confusion was expressed in the August number of this journal. The British Standards Institution has in course of preparation a Standard Notation, from which the notation used in B.S. 114: 1957 has been taken in advance. The substitution of this new notation after the comments on the draft had been received is a high-handed action that is much to be regretted, for those who were asked for their comments had no opportunity of giving their views on this important part of the Code.

It may be desirable to point out some mistakes in the Code as printed:

Clause 306c, second footnote—for $\frac{d_1}{d}$ substitute $\frac{d_1}{d_s}$.

Equation 7—

for $\left(\frac{d_s}{d^2}\right)$ substitute $\left(\frac{d_s}{d_1}\right)^2$.

Clause 314c, fifth line—for tube substitute cube. This mistake also occurs in Clause 322d, line 5.

Clause 701, last line—for recovering substitute re-covering.

These and other errors of less importance have been corrected in the Code as provided in the revised edition (now available) of "Explanatory Handbook on the British Standard Code of Practice, No. 114: 1957," by Scott, Glanville, and Thomas.*—Ed.]

* See page 410.

Prefabricated Expansion Joints.

In the construction of a culvert at Little Barford power station the expansion jointing material was prefabricated at the makers' factory from rolls of strip 9 in. wide and despatched to the site as work progressed for use between the sections of a reinforced concrete culvert 9 ft. 6 in. by 8 ft. 4 in. in cross section, and comprising three channels. *Fig.* 1 shows a prefabricated joint, *Fig.* 2 shows it in position, and *Fig.* 3 shows the completion of one section with half of the width of the jointing material projecting ready to be concreted into the next section. The material is kept in position by using a stop-board in two parts, as shown in *Fig.* 4 (a photograph taken on another site). The contractors are the Mitchell Construction Company, and the jointing material was supplied by the Micanite & Insulators Co., Ltd.

Fig. 1.

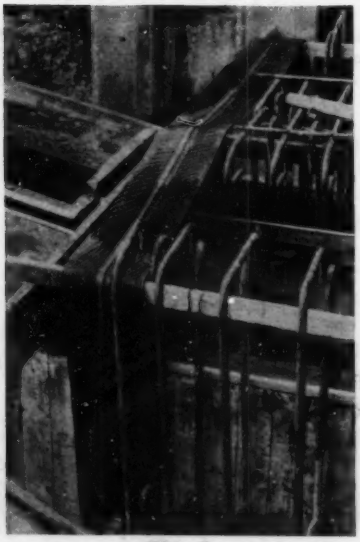


Fig. 2.

Fig. 3.

Fig. 4.

Photographs of Tunnel Work in progress and Segment Moulds used

By kind permission of
HOWARD FARROW LTD.

CONSULT

STELMO

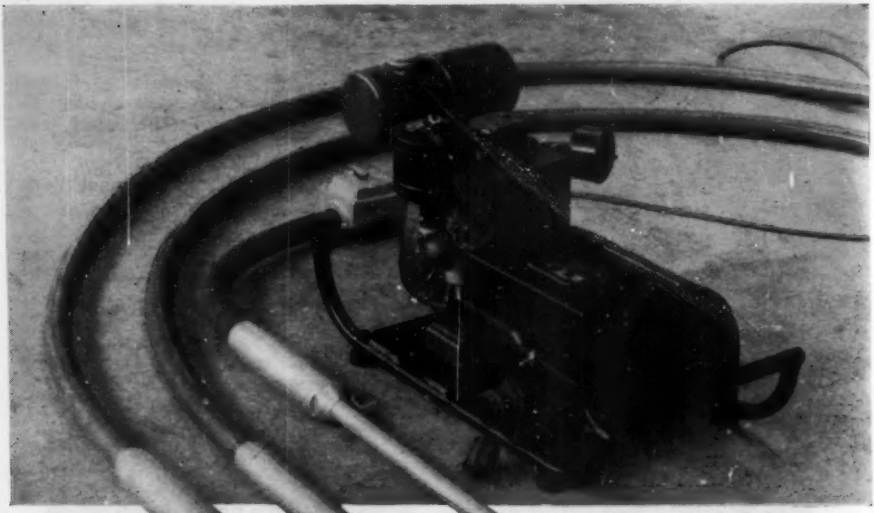
FOR TUNNEL SEGMENT MOULDS AND MOVING FORMWORK FOR TUNNEL LININGS

specifically designed to suit your requirements

STELMO *the most comprehensive mould service in the world*

STELMO LTD., 275 SHAKESPEARE ROAD, LONDON, S.E. 24

Telephone : Brixton 4201



200 cycles INTERNAL VIBRATORS without flexible drives

ALLAM

This new internal vibrator dispenses with the use of flexible drives. It has a frequency of 12,000 r.p.m. which, combined with amplitude, provides exceptional compaction of very harsh mixes. Vibrators of varying sizes, together with single- and multi-tool generators (Petrol, Diesel, and Electric drives), make this the most versatile range of internal vibrators so far available. It is in full production, and has already proved of considerable value to Contractors, Builders, and Precast Concrete Makers. Complete details of these and the range of Allam Vibrating Equipment will be sent on request.

E·P·ALLAM & CO. LTD.

LONDON: 45 Great Peter Street, S.W.1. · *Telephone:* Abbey 6353 (5 lines)
SCOTLAND: 39 Cavendish St., Glasgow, C.5 *Tel.: South 0186* Works: Southend-on-Sea *Tel.: Eastwood 55243*

AGENTS:
Strangford, Ltd., Belfast and Dublin. A. Gunn & Co. Ltd., Altrincham, Cheshire.
Donald Bates (Plant) Ltd., Doncaster. Howard Walton, Newcastle-on-Tyne.
Kwikform, Ltd., Birmingham. O. L. Davies, Ltd., Port Talbot, Glam.

Test to Destruction of a Prestressed Composite Slab.

A LOADING test was recently made of the floor slab shown in *Figs.* 1 and 2. The slab consisted of two precast prestressed planks, 5½ in. by 2⅞ in., rebated on the top faces. Each plank was prestressed with twenty-four 12-gauge wires which were tensioned to about 80 tons per square inch. The planks were placed at 16-in. centres and hollow-clay floor blocks, 6 in. by 12 in. by 12 in., were fitted into the rebates. Ordinary-grade 1 : 2 : 4 concrete was cast in place to form ribs and a top slab 2½ in. thick. The ribs were bonded to the planks by ⅜-in. mild steel stirrups cast into the planks at 15-in. centres. The in-situ concrete was made under conditions corresponding to the worst which may be experienced on a site. The slab was simply supported at each end on round steel bars to provide a span of 30 ft. 5 in., and loaded with precast blocks 3 ft. long by 11 in. wide and weighing about 70 lb. each. The slab was designed for a live load of 60 lb. per square foot.

The deflection was measured by dial gauges on the underside of the ribs, except during the final test when deflections exceeding 1 in. were measured with calipers or with a scale. The results are indicated in *Fig.* 3. The strains were measured at three places by Huggenberger extensometers, attached to the top and edge of the in-situ concrete by means of loops of wire previously cast in, and spring-steel needles. At an overload of 50 per cent. the strain was about $2{\cdot}1 \times 10^{-4}$ and the neutral axis was well inside the rib. In the first test 150 per cent. of the design load was imposed and removed. The slab was then loaded to 50 per cent. of the design load and the load left in position for several days so that deflections due to creep could be measured.

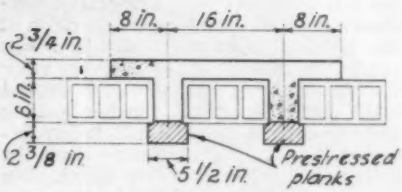


Fig. 1.

Fig. 2.

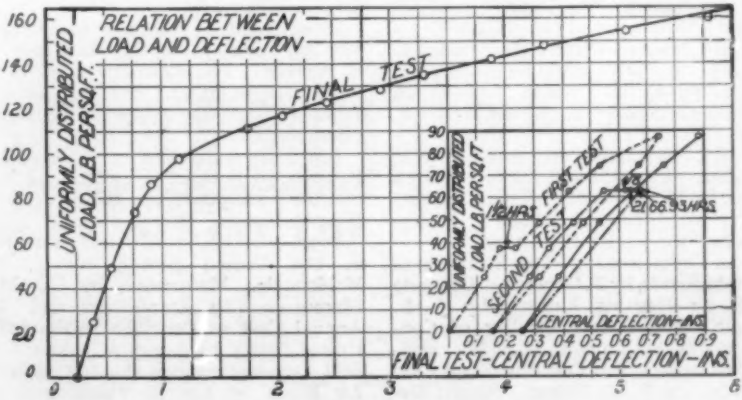


Fig. 3.

The slab was then tested to destruction. It was supported centrally by a 7-tons jack and the load was increased and the jack slowly released until the slab carried the full load. Vertical hair-cracks were observed on the plank at the junction of the hollow blocks when the load was 123 lb. per square foot, or just over twice the design load, but the slab showed little sign of distress. Further loading caused larger deflections and failure occurred (*Fig.* 4) at almost three times the design load. Inspection of the broken slab showed that the bond between the precast plank and the in-situ concrete had been largely destroyed, and that the stirrups had failed.

The panel was designed to fail in tension, the ultimate bending moment being calculated from the expression

$$A_s.t_{ult}\left(1 - \frac{\gamma}{\alpha}.\frac{A_s.t_u}{c.r.b.d^1}\right)d^1 *$$

The predicted ultimate load was 193 lb. per square foot, and was in close agreement with the actual ultimate load of 191 lb. per square foot. The average strains for loads within the working range indicated that there was a considerable margin of strength, despite the inferior quality of the in-filling concrete.

Fig. 4.

The test panel was designed by Messrs. Clarke, Nicholls & Marcel, consulting engineers, Bristol, and tested in conjunction with the Civil Engineering Department of the University of Bristol and the Bristol Stone and Concrete Co., Ltd.

* "The Analysis of Prestressed Concrete Structures", by P. B. Morice. Proceedings I.C.E., March 1957.

International Congress on Concrete Roads.

THE following papers were presented to the International Concrete Road Congress held at Rome in October last. (The promoters of the Congress claim that half a million words were written and spoken in the papers and discussions.)

From Belgium—Concrete Secondary Roads, by A. Revyn.

From Denmark—The Riding Quality of Concrete Roads, by H. H. Ravn.

From France—Prestressed Concrete Runway at Maison-Blanche Airport, Algiers, by R. de l'Hortet. Tests on Prestressed Concrete Roads, by A. Mayer.

From Germany—Sub-grades and Foundations, by Rudolf Dittrich. Trunk Roads, by K. A. Damm. Urban Express Roads, by Johannes Schlums. Motorways in Europe, by H. Kunde.

From Great Britain—The Economy of Concrete Roads, by P. Gooding. Concrete Roads on Housing Estates, by J. L. Beckett. The Riding Quality of Concrete Roads, by Reginald A. Kidd. British Developments in Concrete Road Construction, by J. M. Fisher. Recent Developments in Concrete Airfield Runway Design and Construction in Great Britain, by J. M. Watson. Concrete Roads—What of the Future ? by D. R. Sharp.

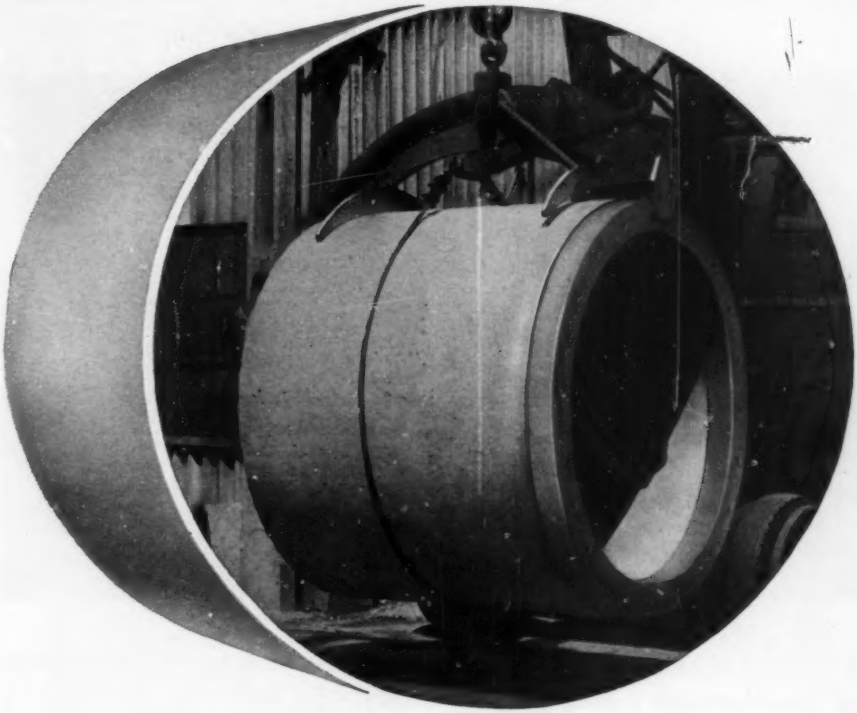
From Italy—Soils and Foundations, by R. Ariano.

From Norway—Experience with Concrete Roads in Norway, by Thor Larsen. Concrete Airfield Runways in Norway, by Gunnar Vigerust.

From Sweden—Concrete Runways on Swedish Airfields, by H. Blomgren and B. Örbom. The Calculation of Settlement Stresses in Concrete Roads due to Consolidation of the Subsoil, by N. Odemark.

From Switzerland—Concrete Roads for Farmers, by P. Regamey. Life and Maintenance of Concrete Roads, by E. Brandenberger.

From the U.S.A.—Urban Expressways in the United States, by J. Carl McMonagle. Motorways, by Harold L. Plummer. The Durability and Low Annual Cost of Concrete Roads in the United States, by James A. Foster. Airfield Development by the United States Air Force, by Lee B. Washbourne and C. M. Bell.



THIS PRECAST CONCRETE CYLINDER is used to form Prestressed Jetty Supports — each 65′ long. The cylinder has an outer diameter of 6′, internally 4′ 11½″ and with a length of 4′ 11¼″. The cored holes are formed in the walls to take Lee McCall bars, passing through thirteen such units and are anchored to steel rings at each end.

COSTAIN
CONCRETE CO. LTD

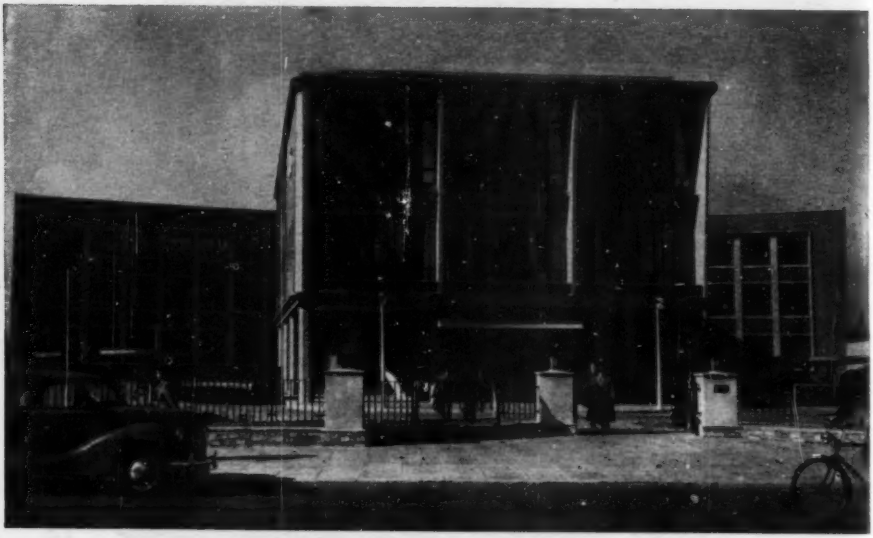
The units were used in the new Erith Jetty, constructed for Messrs. William Cory and Son Ltd. The Contractors were Messrs. Holloway Bros. (London) Ltd., and the Consulting Engineers were Sir William Halcrow and Partners.

LONDON & SOUTHERN COUNTIES
Duncan House, Dolphin Square, London, S.W.1. Telephone: Victoria 3172/4

SCOTLAND & NORTHERN COUNTIES
Coltness Factory, Newmains, Lanarkshire. Telephone: Wishaw 880

WALES & WEST COUNTRY
Cowbridge Road, Bridgend, Glam. Telephone: Bridgend 961

LANCS., YORKS. & MIDLANDS
R. Costain & Sons (Liverpool) Ltd., Barlows Lane, Liverpool, 9. Telephone: Aintree 4141/5



333 Simplex Cast-in-situ Concrete Piles were used in the foundations of the Municipal College Extensions in Anglesey Road, Portsmouth

Architect to the City of Portsmouth: F. Mellor, Esq., F.R.I.B.A.

Write for Illustrated Brochure

SIMPLEX CONCRETE PILES LTD.

25 BRECHIN PLACE, SOUTH KENSINGTON, LONDON, S.W.7

Telephone: Fremantle 0035-6

New Government Offices in Manchester.

In *Fig.* 1 is shown a drawing of new Government buildings eighteen stories high, now in course of construction in Manchester. The building is to accommodate between 1200 and 1300 Civil servants. The structure, which has a reinforced concrete frame, is part of a scheme costing £955,000.

A new type of crane (*Fig.* 2), with a tower 130 ft. high and a jib 98 ft. 6 in. long, is being used. The crane, which is supplied by Messrs. Abelson & Co. (Engineers), Ltd., has lifting capacities from 4 tons at a radius of 33 ft. and a height of 195 ft. to 1½ tons at a radius of 100 ft. and a height of 123 ft.

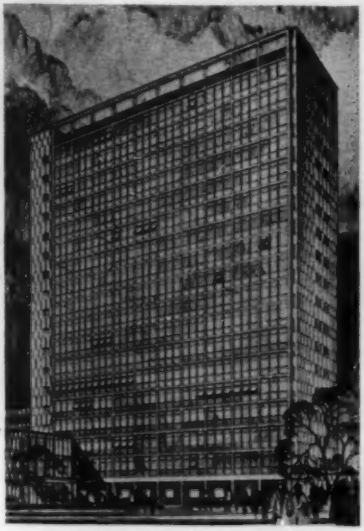


Fig. 1.—New Government Offices, Manchester.

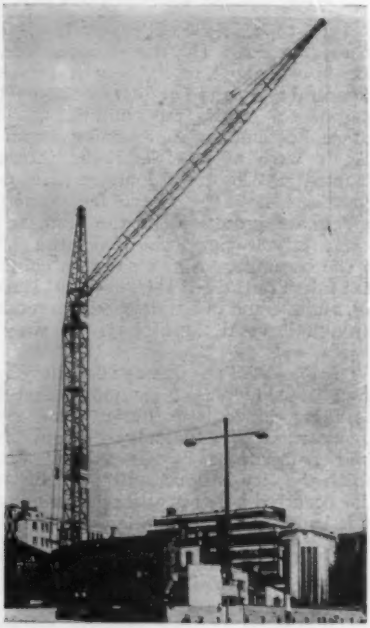


Fig. 2.—New Type of Crane.

"Concrete and Constructional Engineering" Prize Design.

The prize of £25 awarded each year by the proprietors of this journal for competition amongst the students at the Course on Concrete Technology at Imperial College, University of London, has this year been awarded to Mr. A. D. Edwards, B.Sc., D.I.C., A.M.I.C.E.

The competition, which was set by Professor A. L. L. Baker, D.Sc., M.I.C.E., Professor of Concrete Technology, was the development of an area of London around Billingsgate Fish Market. The winning design is for a fish market with a "shell" roof and a multiple-story building. The assessor was Mr. Leslie Turner, M.I.C.E., a former President of the Institution of Structural Engineers, who in his report states that full and extremely well presented calculations were included for the shell roofs and for the multiple-story frame designed on the plastic-hinge theory.

The competitors next in order of merit were Mr. G. C. B. Auger and Mr. X. V. Fernandez.

Earthquake Damage in Mexico City.

In July, 1957, Mexico City was shaken by an earthquake. The maximum acceleration is estimated to have been between 0·05*g* and 0·1*g*, and extensive damage was caused to many tall buildings. The external columns of the building shown in *Fig.* 1 were of steel and the internal columns and floors of concrete; its collapse is believed to have been due to inadequate provision for the transfer of horizontal shearing forces from the slabs to the columns. *Fig.* 2 shows a column that failed in the tall International Building, and a crack in a wall, which extended through several stories, is shown in *Fig.* 3.

The extent of the damage is believed to have been increased by many factors, including inadequate design and poor construction, the difficulty of providing solid foundations in the ground upon which the city is built, and the collisions that occurred between adjacent buildings. It is believed also that the period of the shock-waves coincided with the natural frequencies of some of the buildings, and that the consequent resonant vibrations produced horizontal forces greatly in excess of those allowed for in the designs.

Fig. 2.

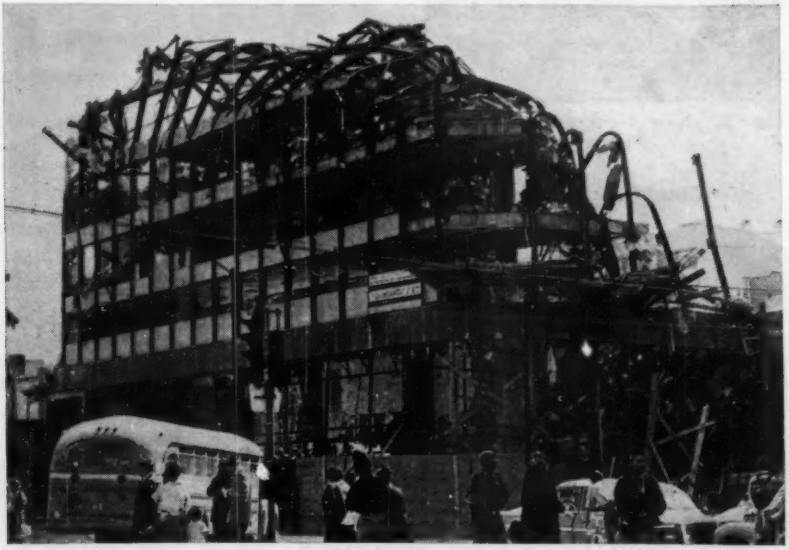


Fig. 1.

remember to specify "Sternson" for every concreting job

Obtain the very best results by insisting on STERNSON PRODUCTS. Whatever the need — waterproofing, hardening, bonding or improved acceleration — there is a specific STERNSON formula which has been tested and proved under the most severe climatic and working conditions.

ADVISORY SERVICE

With 35 years practical experience our technical department can offer constructive assistance on specific concrete problems including the preparation of complete specifications.

STERNSON No. 205
Transparent Surface Waterproofer

STERNSON No. 300
Waterproofing for concrete, mortar

STERNSON No. 310
Accelerator, Hardener, Waterproofer

STERNSON No. 340
Accelerator, Hardener, Waterproofer

STERNSON No. 355
Quick-set Liquid

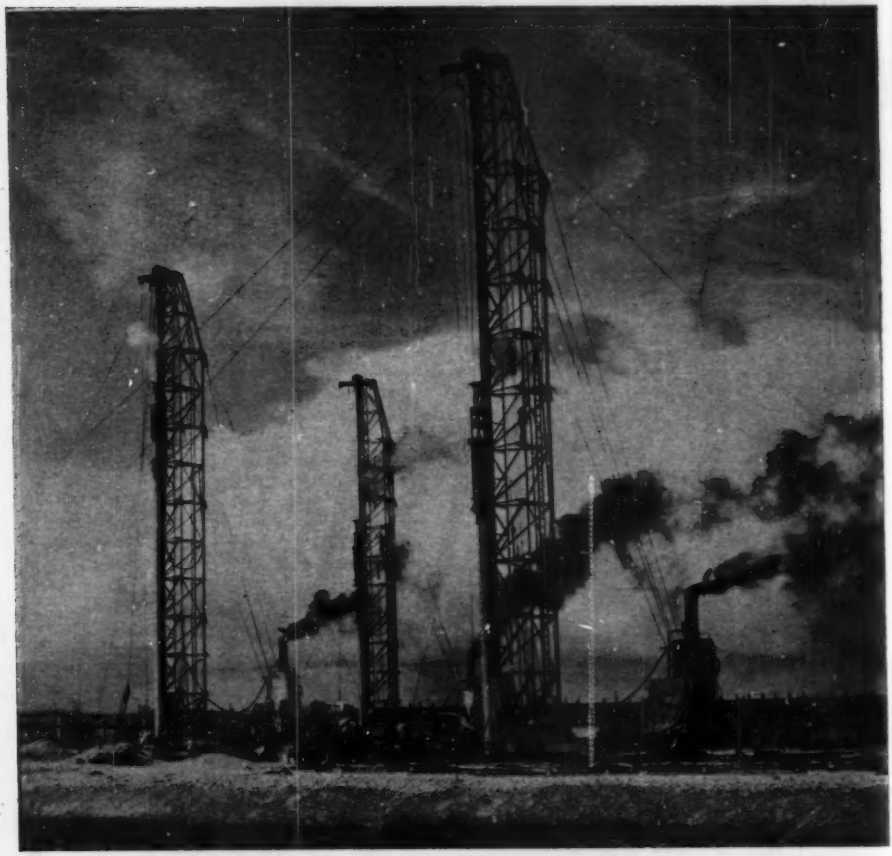
STERNSON No. 600
Metallic Jointing Material

STERNSON No. 610
Metallic Bonding Material

STERNSON No. 620
Metallic Hardening Material

STUART B. DICKENS LTD.

36 Victoria Street, London, S.W.1. *Telephone: Abbey 4930 & 6157.*
Works: Manor Way, Boreham Wood, Herts. *Telephone: Elstree 2211*



The VIBRO process is based on correct engineering principles and ensures the formation of piles of the precise length and size to suit the specified working loads.

The three Vibro plants shown above are forming 17" diameter piles varying from 60 to 70 feet in length, designed to carry working loads of 60 tons each.

BSP

VIBRO

CAST-IN-PLACE REINFORCED CONCRETE PILES

THE BRITISH STEEL PILING COMPANY LIMITED
10 HAYMARKET LONDON SW1

Fig. 3.

Investigations are continuing, and it is probable that the requirements of the Mexico City building code will be revised in an attempt to avoid recurrence of such damage.

The Changing Mind.

BRITISH engineers who see the Government's proposals for capital expenditure change as frequently as the state of the nation's finances and the opinion abroad of the value of sterling, will derive some comfort from the following note from "Engineering News-Record." "In two days of hot debate, the U.S. House of Representatives last week killed the idea of building a four-lane traffic tunnel across (that's what the bill said) the Potomac River, changed its mind, decided instead to build a six-lane bridge that would be 'a fixed-span bascule' structure; then ordered that no tolls could be charged for the tunnel that isn't going to be built; and that access roads for the bridge that won't be built either may not be tunnelled under Arlington cemetery. Looking at this handiwork on the second day, the House finally killed the whole business, and left matters where they stood originally—no bridge, no tunnel, no legislation."

⅝" NOM. DIA.
REINFORCING RODS
£29 PER TON DELIVERED
50 tons available, lengths 20 ft. and 25 ft. at your option. Minimum 2-tons lots. Slightly curved. We have recently sold 200 tons to some of the biggest Contractors in Great Britain. Send for free sample.
COX & DANKS LTD.
FREDERICK ROAD, SALFORD, 6, LANCS.
Telephone: PENdleton 2481

WASHED
BALLAST, SAND, SHINGLE &
Crushed Aggregate for Reinforced Concrete
WILLIAM BOYER & SONS, LTD.
Sand and Ballast Specialists,
IRONGATE WHARF, PADDINGTON BASIN, W.
DELIVERED DIRECT TO ANY CONTRACT BY MOTOR LORRY.
Quotations on Application.
Telephone: Paddington 2824 (3 lines).
MEMBERS OF B.S. & A.T.A.

Defective Aggregates in Scotland.

SOME notes on the deterioration of concrete made with certain Scottish aggregates are given in "Building Research 1956" (H.M. Stationery Office. Price 5*s.* 9*d.*).

In the course of a study of the dimensional changes of natural rock aggregates on wetting and drying, and the effect of such changes on the durability of concrete made with these aggregates, it was found that concrete products such as kerbs, blocks, and slabs sometimes failed by cracking and disintegration after only one or two years' exposure to the weather. Previous investigations had shown that, while this type of failure could often be ascribed to inadequate control of quality, there were other cases in which it appeared to be due solely to the use of a particular rock aggregate; certain dolerites (whin-stones) in particular seemed to be objectionable, but no reliable test had been devised to distinguish these from other dolerites that were harmless.

It is now known that other aggregates can produce the defects in concrete hitherto associated only with the use of dolerite. There have been two examples of the rapid breakdown on exposure of precast blocks made with Scottish gravels from different sources. In both cases the blocks were well made and appeared to be of very good quality, yet a high proportion of them became defective. Dolerites differ considerably in their shrinkage on drying and expansion on re-wetting. Further, shrinkage of the aggregate produced a corresponding increase in the drying-shrinkage of concrete made with it. Concrete made with the two gravels mentioned also had abnormally high drying-shrinkage.

These and other observations suggest that abnormal moisture movement of the aggregate, of whatever type, may be important in affecting the durability of concrete by causing surface cracks which make the concrete readily susceptible to damage by frost. The movement of the rock may be due to the presence in it of clay capable of absorbing or giving up water, with accompanying volume changes; experiments on this possibility are now in progress.

A Course on Concrete Roads.

A POST-GRADUATE course of nine lectures on the construction of concrete and soil-cement roads has been organised by Kingston Technical College in conjunction with the Cement and Concrete Association. The lectures will be given by members of the staff of the Cement and Concrete Association. Some knowledge of highway engineering will be required as a qualification for entry to the course. Lectures will be on Friday afternoons starting on 17 January 1958; the fee for the course will be £1 1*s.* Application forms may be obtained from the Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W.1, or from Kingston Technical College, Fassett Road, Kingston-upon-Thames.

The German Reinforced Concrete Institute.

A BROCHURE* has been issued to commemorate the fiftieth anniversary of the Deutscher Ausschuss für Stahlbeton. In addition to an account of the activities of the Institute during the half century photographs and notes are given of some of the more important concrete structures built in Germany, the earliest of which is a reinforced concrete arched footbridge with a span of 130 ft. built near Stettin in 1888. Another photograph shows the erection of the reinforcement for the first "shell" roof—a dome with a span of 53 ft. and a thickness of 1¾ in. built at the Zeiss works in 1923. A feature of the brochure is a number of biographies of eminent engineers who have been connected with the Institute.

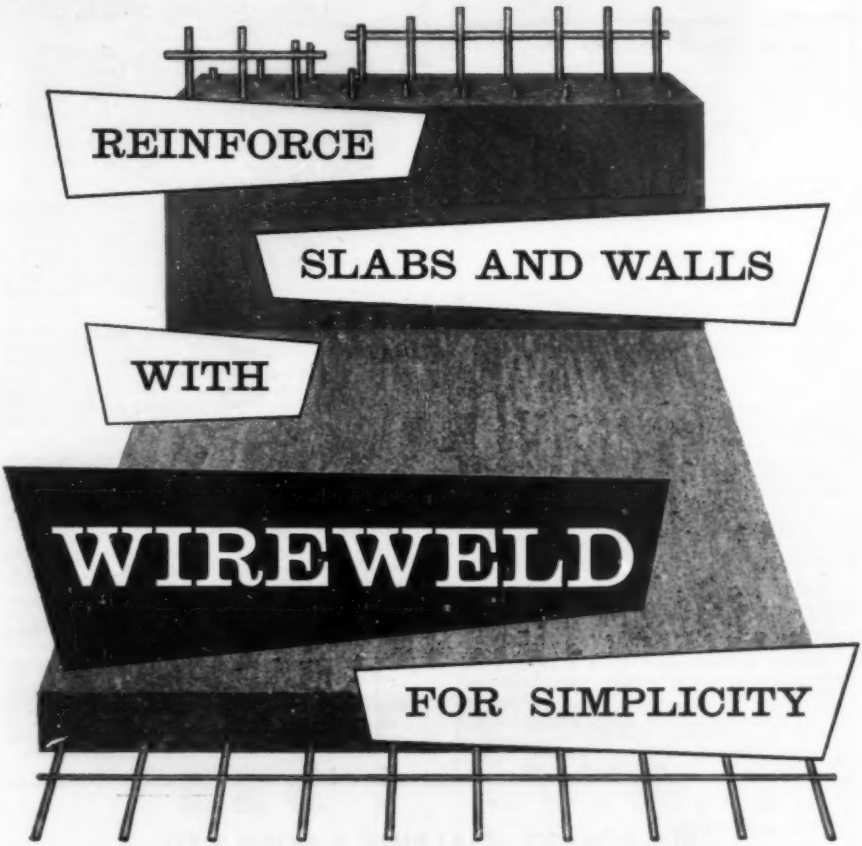
* "50 Jahre Deutscher Ausschuss für Stahlbeton: 1907-1957." [Berlin: Wilhelm Ernst & Sohn. Price 24 D.M.]

Lectures on Building.

THE following lectures have been arranged by the Ministry of Works. Admission is free.

Safety in the Building Industry, by J. A. Hayward. Technical College, Tonbridge Road, Maidstone. December 16. 7.15 p.m.

Powered Hand Tools, by A. F. Coare. Technical College, Belvedere, Erith. December 16. 7 p.m.



WIREWELD reinforcement is a high tensile steel fabric, manufactured from hard drawn steel wire electrically welded at all intersections to B.S. 1221, Part A. Made in oblong mesh and square mesh.

If you want to put steel into concrete, get in touch with

G.K.N. Reinforcements Ltd.

(FORMERLY TWISTEEL REINFORCEMENT LTD.)

43 UPPER GROSVENOR STREET, LONDON, W.1 (GROSVENOR 8101)

SMETHWICK, BIRMINGHAM: *Alma Street, Smethwick 40, Staffs. (Smethwick 1991).* MANCHESTER: *7 Oxford Road, Manchester 1 (Ardwick 1691).* GLASGOW: *30 Pinkston Road, Glasgow C.4 (Bell 2444).* MIDDLESBROUGH: *Dundas Chambers, Dundas Mews, Middlesbrough (Middlesbrough 3843).* BRISTOL: *16 Clare Street, Bristol (Bristol 21555).* LEICESTER: *58-60 Rutland Street, Leicester (Leicester 27572).* BELFAST: *Norman MacNaughton & Sons Ltd., Corporation Street, Belfast (Belfast 24641).* *Works:* CARDIFF, SMETHWICK, WIGAN & GLASGOW.

MISCELLANEOUS ADVERTISEMENTS.

Situations Wanted, 4d. a word : minimum, 7s. 6d. Situations Vacant, 5d. a word : minimum, 10s. Other miscellaneous advertisements, 5d. a word : minimum 10s. Displayed advertisements, 35s. per column inch. Box number 1s. extra.

Advertisements must reach this office by the 23rd of the month preceding publication.

SITUATIONS VACANT.

SITUATIONS VACANT. Experienced reinforced concrete designer-detailers required. Opportunity of contemporary design experience. Salaries up to £1100 according to experience. Five-days' week. JOHN DE BREMAEKER & PARTNERS, 3 Southampton Place, London, W.C.1. Chancery 3785.

SITUATIONS VACANT. Design engineers required by UDALLS PRESTRESSED CONCRETE LTD. Good salary and prospects for well-qualified men. Write to West Quay Road, Southampton.

SITUATIONS VACANT. Structural steelwork designers required to be engaged on comprehensive building and civil engineering projects. Applicants should be capable of handling entire projects under direct supervision of principals of the firm. Salary paid will be commensurate with ability and experience. Apply, giving details of experience, etc., to GEORGE DAVIE, CRAWFORD & PARTNERS, Consulting Engineers, 26 Woodside Place, Glasgow, C.3.

SITUATIONS VACANT. Reinforced concrete designer-detailers required to be engaged on comprehensive building and civil engineering projects. Applicants should be capable of handling projects under direct supervision of principals of the firm. Salary paid will be commensurate with ability and experience. Apply, giving details of experience, etc., to GEORGE DAVIE, CRAWFORD & PARTNERS, Consulting Engineers, 26 Woodside Place, Glasgow, C.3.

SITUATIONS VACANT. Reinforced concrete detailers required. Interesting work. Five-days week. Luncheon vouchers. Write, giving details of experience, to C. J. PELL & PARTNERS, 4 Manchester Square, London, W.1.

THE EXPANDED METAL COMPANY LTD.

Reinforced concrete designers and detailers required for permanent positions in London, West Hartlepool, Birmingham, and Manchester. Five-days week. Staff pension scheme, etc. Apply in writing, giving brief details of experience, and salary required, to the Chief Engineer, THE EXPANDED METAL CO. LTD., 16 Caxton Street, London, S.W.1.

SITUATIONS VACANT. Taylor Woodrow Construction Ltd. invite applications from senior civil and structural engineers for important work on the design and construction of nuclear power stations. Excellent conditions of employment including pension scheme participation, and first-class opportunities are offered. Applications should be addressed to D.A.J.B., PERSONNEL DEPARTMENT, Ruislip Road, Southall, Middlesex.

SITUATIONS VACANT. Assistant engineers and designer-draughtsmen required for varied and interesting work on reinforced concrete structures for industrial, commercial, medical and residential buildings. Five-days week. Luncheon vouchers. Apply, with details of experience, and salary required, to JOHN F. FARQUHARSON & PARTNERS, Chartered Structural Engineers, 34 Queen Anne Street, London, W.1.

SITUATION VACANT. Senior reinforced concrete engineer required for London consultant's office. Excellent opportunity for suitable applicant. Write, giving details of experience, which will be treated in confidence, to Box 4480, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Experienced engineer, preferably though not necessarily A.M.I.Mech.E. or A.M.I.C.E., required for position with large company in Middle East. Age preferably 30–35. Basic salary according to experience, plus free furnished quarters and living allowance. Apply, with full details, to Box 4481, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATIONS VACANT. Consulting engineers require assistants for design and detailing of reinforced and prestressed concrete structures. At least three years' drawing-office experience essential. Variety of interesting work, and congenial conditions. Apply in writing only, giving details of training and experience, to R. TRAVERS MORGAN & PARTNERS, 11 Victoria Street, London, S.W.1.

SIR ROBERT McALPINE & SONS LTD.

as a Member Firm of

THE NUCLEAR POWER PLANT CO. LTD.

require

REINFORCED CONCRETE DRAUGHTSMEN

with a knowledge of design. The office is situated at Knutsford, Cheshire.

Written application, with an accompanying sheet giving full details of age, education, and qualifications, should be sent to

A. HOUGHTON BROWN,
Booths Hall,
Knutsford,
Cheshire.

SENIOR REINFORCED CONCRETE ENGINEER-DESIGNER required by a large manufacturing organisation with branches throughout the U.K. Must be conversant with Code of Practice, L.C.C. Bye-Laws, and able to design light-frame structures and floor beams from estimating stage to final details. Liaison with production and sales departments of prime importance. First-class working conditions, pension scheme. Position calls for initiative and responsibility, and gives the right man a really good opportunity for progress. Salary according to experience and qualifications. Apply, giving full details and experience, etc., to Box No. A. 630, CENTRAL NEWS LTD., Pemberton House, East Harding Street, London, E.C.4.

THE LUMMUS COMPANY LIMITED

designing Engineers and Constructors for Industry, invite applications from SENIOR STRUCTURAL STEEL AND REINFORCED CONCRETE DRAUGHTSMEN. Generous salaries and first-class working conditions in a modern drawing office one minute from Piccadilly Circus. Five-days week, Sickness and Pension Schemes. Luncheon and Social Club where subsidised meals are obtainable. House purchase assistance scheme.

Apply in writing to the PERSONNEL OFFICER, THE LUMMUS COMPANY LIMITED, Imperial House, 80 Regent Street, London, W.1. or telephone Regent 4030 for an interview.

Opportunities for careers in Reinforced Concrete...

on the staff of BRC

There are vacancies for Reinforced Concrete Designers in the London Office at 54 Grosvenor Street. Designs in prestressed and shell concrete are prepared at this office, in addition to a wide variety in normal Reinforced Concrete. Working conditions are excellent, the office being equipped with controlled heating and ventilation. Five day week — Canteen — Pension Scheme. Top rate salaries are paid to Designers, Designer-Detailers and Detailers in accordance with ability and experience. Openings available for graduates and men with H.N.C. Apprenticeship scheme available for students of good educational standard.

THE BRITISH REINFORCED CONCRETE ENGINEERING CO. LTD., STAFFORD

Chief Engineer:
A. P. MASON, B.Sc., M.I.C.E., M.I.Struct.E., M.ASCE

M-W.841

Profit-Sharing with Truscon

In our staff advertisements we often announce the usual string of " fringe " attractions : Pension Scheme, with free Life Assurance and Widow's and Dependant's benefits, five-day week, overtime paid, canteens in most offices, generous holidays, progressive and interesting work, etc., etc. We believe our standards in this respect to be at least level with the best ; but there is one *unusual* attraction about working in the Truscon team—our Profit-Sharing Scheme. Each of us is regarded as being a " shareholder " to the extent of 200 of the Company's Ordinary Shares for each £100 of qualifying salary. As a result, just before Christmas, we receive a " dividend " equivalent to the actual amount paid on the Ordinary Shares for the previous year. This Scheme gives practical expression to our fundamental belief that an employee has a " vested interest " in the Company he works for. We at Truscon are not unwilling to extend it to anyone who is going to pull his weight. *That's why we will always find room for a good man.*

The Trussed Concrete Steel Company Limited.

35/41 Lower Marsh, London SE1

SITUATION VACANT. Senior engineer for progressive firm of consulting engineers, for either Manchester or London office. University education preferred. A.M.I.C.E. essential. Good experience required, together with ability to contact clients. Age 28-35. Apply in writing, giving references, salary required, and area preferred, together with commencing date, to Box 4483, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Structural engineer in training wanted by large building organisation. Applicant will work first in the London area, but should be mobile. Some experience desirable in up-to-date concrete techniques including prestressing. Applicant will be trained in practical research and concrete quality control, with opportunity to proceed to structural work on sites. Apply, in writing, to THE UNIT CONSTRUCTION CO. LTD., Faggs Road, Feltham, Middlesex.

SITUATIONS VACANT. A qualified design engineer and detailer-draughtsman required in the drawing office by civil engineering contractors specialising in foundations. Excellent prospects, salary, bonus and pension scheme. Applications in writing, stating age, experience, and salary required, to WEST'S PILING & CONSTRUCTION CO. LTD., Bath Road, Harmondsworth, West Drayton, Middlesex.

SITUATIONS VACANT. W. & C. FRENCH LTD. urgently require structural designers for work in head office. Applicants must have ability and speed in preparing preliminary schemes for tenders, and to design and supervise the detailing of all types of reinforced concrete structures. Applicants should also be conversant with one or more of the following subjects: design of shuttering and temporary works; soil mechanics; concrete mix design; prestressed concrete. Please apply in writing, stating age, salary required, and full details of experience, to PERSONNEL MANAGER, 50 Epping New Road, Buckhurst Hill, Essex.

SITUATION VACANT. Capable designer-draughtsman required by Westminster consulting engineers. Moderate-size firm. Varied structural work, mainly reinforced concrete. Five-days week. Luncheon vouchers. Box 4486, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Experienced design engineer required for responsible work by moderate-size firm of West minster consulting engineers. Varied structural and civil engineering work. Five-days week. Luncheon vouchers. Box 4485, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Consulting structural engineers require section leader able to design various reinforced concrete structures, also supervise detailing. Varied work. Five-days week. Apply, stating full details of experience, and salary required, to ALAN MARSHALL & PARTNERS, 73-74 High Holborn, London, W.C.1.

SITUATION VACANT. Reinforced concrete designer required for small but expanding firm of consultants engaged mainly on foundation and building-frame work. Only fully-experienced men need apply. State experience over last ten years. Applications will be treated in confidence, and applicants will be expected to produce examples of their work. Salary at least £1500 per annum. Box 4489, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

FREDERICK S. SNOW AND PARTNERS

require ASSISTANT ENGINEERS, DESIGNER/DETAILERS, and DETAILERS, for work in London Offices on varied and interesting Reinforced Concrete and Structural Steelwork Projects. Salary according to ability and experience. Luncheon Vouchers, Superannuation Scheme. Write for appointment, stating age and experience, to: Monro Building, Wellington Street, London, W.C.2.

SITUATION VACANT. Reinforced concrete designer-draughtsman required. Familiar with frame structures and general design to Code of Practice. Good prospects. Five-days week, luncheon vouchers, and pension scheme. Apply, stating experience and salary required, to JOHNSON'S REINFORCED CONCRETE ENGINEERING CO. LTD., Artillery House, Artillery Row, London, S.W.1.

SITUATION VACANT. Experienced reinforced concrete designer required by consulting engineers as checker. Retired persons will be considered for this post. Attractive salary and prospects. Office hours 9.30 a.m. to 5.30 p.m., and one Saturday morning in six. For further particulars apply PERSONNEL DEPARTMENT, SIR BRUCE WHITE, WOLFE BARRY & PARTNERS, 1 Lygon Place, Grosvenor Gardens, London, S.W.1. Telephone Sloane 0431.

SITUATION VACANT. Civil engineer required by consulting engineers near Victoria, London, for varied, interesting, and responsible work. Applicants should be qualified, and have at least ten years' experience in the design of reinforced and prestressed concrete, and general foundation work. Applicants must be capable of supervising several jobs running simultaneously. Attractive salary and prospects. Office hours 9.30 a.m. to 5.30 p.m. and one Saturday morning in six. For further particulars apply PERSONNEL DEPARTMENT, SIR BRUCE WHITE, WOLFE BARRY & PARTNERS, 1 Lygon Place, Grosvenor Gardens, London, S.W.1. Telephone Sloane 0431.

SITUATION VACANT. Senior designer-draughtsman required for London head office of well-established constructional engineers. Applicants must have sound knowledge and experience in designing reinforced concrete frames, and various forms of floor, roof and staircase construction, including precast and prestressed, and possess full knowledge of Building Regulations and Codes of Practice, and be able to deal with technical correspondence. Permanent, progressive and pensionable post. Write salary required (this is essential), and experience, to Box 4487, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SERVICES OFFERED.

SERVICES OFFERED. Experienced structural designers offer their services to consulting engineers. Willing to prepare designs and details for all types of structures in reinforced concrete or steel. Box 4484, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

TENDERS INVITED.

TENDERS INVITED for Showroom with 85-ft. frontage, 40-ft. spans, with flats over. Box 4488, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

LICENSEES WANTED.

Manufacturing licences available for well-known and proved continental system of precast stair construction. Details from Box 4482, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

FOR SALE.

(*See also page* 423)

FOR SALE. Steel guttering. Ironwork. Sheet metalwork. E. STEPHENS & SON LTD., Bath Street, London, E.C.1. Clerkenwell 1731.

FOR SALE. Melamine plastic-faced resin-bonded plywood, waterproof exterior grade, recommended for use in the construction of, or linings for, moulds for precast concrete. In thicknesses ¼ in., ⅜ in., ½ in. Full particulars from J. & T. T. BROWN LTD., Stockton Street, West Hartlepool.

FOR SALE. New bar-benders for immediate delivery. Besco No. 2 size for hand-lever operation. Capacity: cold bars up to 4 in. × $\frac{1}{16}$ in; ¾ in. diameter; ¾-in. squares; notches angles 4 in. × $\frac{1}{16}$ in.; hot bars up to 4 in. × ½ in. or equivalent. Special blocks available. Fully illustrated leaflets and price from F. J. EDWARDS LTD., 359 Euston Road, London, N.W.1; Telephone: Euston 4681. Or 41 Water Street, Birmingham, 3; Telephone: Central 7606.

FOR HIRE.

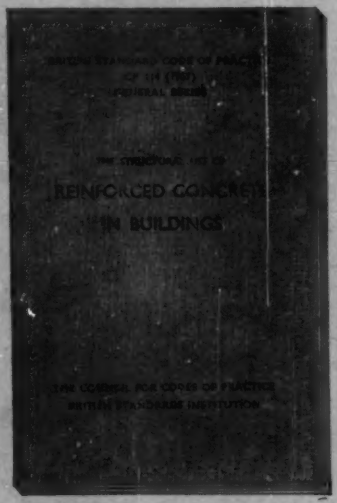
FOR HIRE. Lattice steel erection masts (light and heavy), 30 ft. to 150 ft. high, for immediate hire. BELLMAN, 21 Hobart House, Grosvenor Place, London, S.W.1

TENTOR

REGISTERED TRADE MARK

and CP114 (1957)

Changes in the 1957 Edition of the British Standard Code of Practice, CP 114, make the use of the Tentor Bar, with its high tensile and bond strength, an even more attractive proposition.



You can now make greater use of the high strength of Tentor Bar and also obtain additional savings.
For instance the maximum *tensile* stress for Tentor Bars is now *30,000* lbs./sq.in. giving *a saving of 15%* of the cost of mild steel rounds. Again, the maximum *compressive* stress is now *23,000* lbs./sq.in giving a cost for Tentor still generally less than that for mild steel bars.
Bond stresses are also raised and a more economical design method described.
An information sheet detailing the changes is obtainable on request and revised editions of our literature will be available shortly.
The efficient Tentor service is at your disposal and enquiries are welcomed.

Tentor is manufactured by
Guest Keen & Nettlefolds (S. Wales) Ltd., Cardiff;
McCall & Co. (Sheffield) Ltd., Templeborough, Sheffield;
The United Steel Companies Ltd., Sheffield.

The
TENTOR BAR
Company Limited

43 UPPER GROSVENOR STREET, LONDON W.1 · Tel: GRO 8101

The British Reinforced Concrete Engineering Co. Ltd., Stafford

M-W.791

Published by CONCRETE PUBLICATIONS LTD., 14 Dartmouth Street, London, S.W.1. Telephone: Whitehall 4321
Printed by BUTLER & TANNER LTD., The Selwood Printing Works, Frome and London